THE

AMERICAN JOURNAL

OF

SCIENCE AND ARTS.

CONDUCTED BY

PROFESSORS B. SILLIMAN AND JAMES D. DANA,

IN CONNECTION WITH

PROFESSORS ASA GRAY, AND WOLCOTT GIBBS,
OF CAMBRIDGE,

AND

PROFESSORS S. W. JOHNSON, GEO. J. BRUSH, AND
H. A. NEWTON, OF NEW HAVEN.

SECOND SERIES.

VOL. XLIV.—[WHOLE NUMBER, XCIV.]

Nos. 130, 131, 132.

JULY, SEPTEMBER, NOVEMBER.

NEW HAVEN: EDITORS.
1867.

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

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THE

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JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. I.—*On Perfect Harmony in Music, the Double Diatonic Scale, and an Enharmonic Key-Board for Organs, Piano-fortes, etc.;* by HENRY WARD POOLE, of South Danvers, Mass.

1. SEVENTEEN years ago I published in this Journal* a theory of Perfect Intonation in music, with a description of an organ made to obtain this result, which had then just been completed. The organ was provided with pedals and mechanism by which the large number of pipes necessary for perfect tuning could be played by the common key-board. It was supposed that all music, for the moment, was in some key or scale. This scale the organist could prepare by putting down a single pedal, which had the effect of uniting the twelve finger-keys of each octave with twelve valves, and disconnecting all the others. As the music passed into other scales, by modulation, and other less marked transitions, the player, by touching the pedal of the new scale, made the changes of sounds required. In the present paper, I shall describe a new key-board in which all the sounds contained in the organ are represented, and placed within control of the organist, without aid from pedals or any interior mechanism; and which is practicable for any extent of modulation, or number of notes in the octave. It is uniform in all keys, and the same succession of melodies or harmonies is fingered the same in every signature. The pedal-base is also provided for by an appropriate key-board. I shall also treat of the scale heretofore unnoticed by theorists, to which I have given the name of *Double Diatonic*,† together with other matters bearing upon the theory and practice of perfect harmony.

* Vol. ix, Jan., Mar., 1850.

† See the Mathematical Monthly, ii, 16, 1859.

2. In my former article in this Journal it was maintained that the Prime Seventh with the ratio 4 : 7 was harmonious, admissible and used in music, although this, so far as I have seen, was asserted for the first time.* It is clearly evident that this element enters into music of all kinds, and that the diatonic scale must contain it, or that there must be *two* diatonic scales: which latter supposition is most correct. If only fifths and thirds are admitted in forming a diatonic scale it will naturally be made of the common chords of three roots, namely, the tonic or key-note, the dominant or fifth above, and the subdominant or fifth below. This I have distinguished as the *triple diatonic scale*, which has three intervals in the ratio of 8 : 9, 9 : 10, and 15 : 16. The notes are represented by the syllables Do, Re, Mi, etc., which always bear the same relation to the key-note and to each other. Thus, Do to Re is always as 8 : 9 or a major tone, Re to Mi as 9 : 10 or a minor tone, Mi to Fa as 15 : 16 or a diatonic semitone. No exception is admitted in this rule. Considering the key-note to make 48 vibrations in a given time, we have the

TRIPLE DIATONIC SCALE. Do to Do.

Common chords on Do, Sol *and* Fa.

	DO	RE	MI	FA	SOL	LA	SI	DO
Rel. vibrations,	48	54	60	64	72	80	90	96
	First.	Second.	Third.	Fourth.	Fifth.	Sixth	Seventh.	Octave.
Intervals,		8 : 9	9 : 10	15 : 16	8 : 9	9 : 10	8 : 9	15 : 16

3. But if the ear prefers—and it often does prefer—the subdominant harmony may be suppressed, and the fourth of the scale, Fa, and the sixth, La, may be replaced by the perfect seventh and ninth of the dominant harmony; so that if we still take *Do* as a starting point or first of the scale, we require a *new Fa* and *La*, for which formerly there have been no names. But the perfect seventh, or *flat seventh* as it is called, is already in solmization sung as *Si*♭, taking the sound of *Se*—pronounced by the Italian rules as are all these syllables, and like the English *Say*—and no other name is needed. Below *Si* therefore we take *Se*, and take as first of a scale the *Fa* already given. Then we have the

DOUBLE DIATONIC SCALE. FA to FA.

Common chord on Fa, *chord of* 7 *and* 9 *on* Do.

	FA	SOL	LA	SE	DO	RE	MI	FA
Rel. vibrations,	32	36	40	42	48	54	60	64
or	48	54	60	63	72	81	90	96
	First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Seventh.	Octave.
Intervals,		8 : 9	9 : 10	20 : 21	7 : 8	8 : 9	9 : 10	15 : 16

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* The German "Jahrbuch" of Liebig and Kopp, in a discriminating review of my article in this Journal in 1850, specified this declaration.

4. The reasons for taking the key-note on *Fa* will appear on consideration, but for the present the reader will recollect that if the flat seventh of the natural key is taken—for example B^b with the common chord of C—the ear requires a resolution on the chord of F or *Fa*, which is the controlling note.

5. To sing this scale is easy, provided the intervals of the triple scale are well fixed by their syllables; and it only remains to learn the intervals *La* to *Se*, 20 : 21, and *Se* to *Do*, 7 : 8, which are easily recognized on hearing the harmony which should accompany a lesson in singing. In the last scale are five different intervals in place of the three of the first scale, by which more variety is secured.

6. These two scales contain all that belongs to the major keys; the additional notes required to complete the minor keys will be considered afterwards, as well as those called "accidentals," which are borrowed from related scales. The notation generally employed in music is practically correct, and, without changing the letters or sharps and flats, scales may be noted so that the exact sounds shall be indicated. In all times a singer must know or *feel* the pitch of each note, if he would sing it correctly. If he has learned the intervals by solmization, in the only rational way, or by always giving the same intervals to the same succession of syllables, and if he knows by the written music what intervals are called for, he will give them equally well in the key of C or in C♯, or on the dozen different pitches which can be given between these two sounds. But when we are to deal with fixed sounds, as is necessary when constructing an instrument, or when two fixed instruments may have to play together, it is necessary to know and express the exact sounds required. If the note be C, it will not do to use that which is the key-note of the natural scale for the third of four flats, which is a comma lower, nor for the perfect seventh of D, two sharps, which is lower still. I formerly indicated this distinction by a numerical index, but the following system presents advantages.

7. Every key-note is marked as usual, but with a Roman capital; every major third to these key-notes with Roman lower case, and every perfect seventh with a Gothic capital. The second, fourth and fifth of the triple diatonic scale, being key-notes in other scales, and in the series of key-notes, each a fifth one from another, are accordingly in Roman capitals. So the sixth and seventh of the same scale are thirds of other keys, and marked in letters of the lower case. The two diatonic scales will then be represented thus in the natural key.

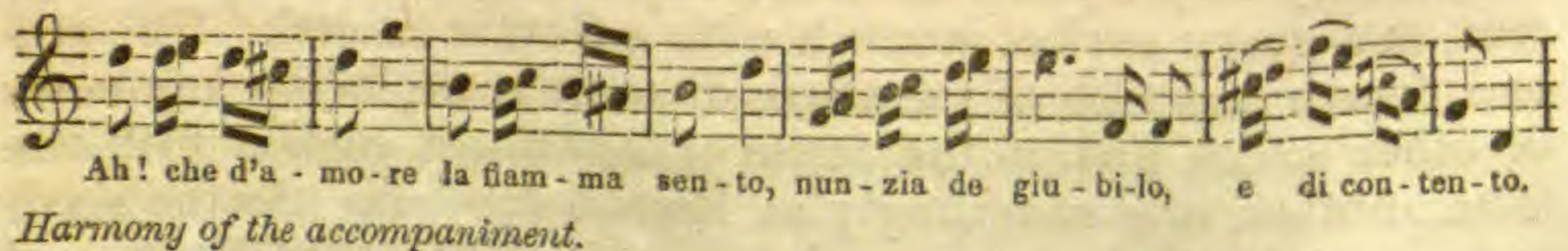
Triple diatonic,	C	D	e	F	G	a	b	C
	Do	Re	mi	Fa	Sol	la	si	Do
Double diatonic,	C	D	e	**F**	G	A	b	C
	Fa	Sol	la	**se**	Do	Re	mi	Fa

8. Much that is curious and interesting concerning this double diatonic scale could be shown, did the character of this article admit, and were it practicable to give musical examples from the masters. It would be seen that the most beautiful, varied and ornate compositions are made from the elements it contains. It has the capacity in certain styles of music of using with much grace accidentals, or chromatics, as they are called; for example, the *si*, the regular leading note to *Do*, and the *Sol♯*, diatonic semitone below *la*, or the leading note to the relative minor; these chromatics always ascending diatonic semitone (15 : 16) to the notes above. Especially is the *si*, or major seventh, used with *Do*, making the ratio of 8 : 15, if it is to be considered as claiming to be attended to as concordant, or as otherwise than as a passing note of a melody. But when perfectly tuned it is heard in harmony, especially with the *mi* and *Sol* with which it is sounded. An example will be given to illustrate this. First, it may be mentioned that besides the three series of notes—key-notes, thirds and sevenths—another series is used, that of the dominant's thirds in the minor scales, the leading notes to the relative minor's key-note. This in each key is *Sol♯*, and is tuned a major third above *mi*; and *mi*, *Sol♯* and *si* form a major common chord (4 : 5 : 6). These notes are expressed in italic letters of the lower-case. The example being the double diatonic scale of G, in one sharp, I shall give this scale with the accidentals introduced in the following melody from Rossini's 'Il Barbiere di Seviglia.' The air will be remembered as appearing in the accompaniment to the song or recitative (for it is all on one note, D or Do, the part which this accompanies), in which Figaro describes his place of business, (*Numero quindici*, etc.), and afterward is the air sung by Almaviva when he has a prospect of seeing Rosina, while at the same time Figaro sings in joy at the sound of his patron's gold.

DOUBLE DIATONIC SCALE IN G, WITH ACCIDENTALS.

G	A	*a♯*	b	**C**	c♯	D	E	f♯	G
FA	*Sol*	(sol♯)	la	**Se**	(si)	Do	RE	mi	FA

Almaviva sings



Harmony of the accompaniment.

G - - - - - - - - - - - - - - - - - D with the 7th - - G

9. Although it is convenient to consider a special strain of music as being in a definite key or scale, and to consider the notes which are sometimes prone to introduce themselves as "accidentals," and in a manner extraneous, yet the truth is that

all such intruders have the excuse of being relatives, with the right of entrance, under certain rules, which the great masters understand. Among the related notes in the scale in G, last given, are C and e, or the fourth and sixth of the double diatonic on the same key-note, G. These are introduced in a passing manner, as in the cadence—a familiar example is found in the *Oh! dolce concento** of Mozart—where the subdominant harmony, not before heard, comes in just before the final dominant and tonic chords. In the example given from Rossini, the third note of the third measure may be C, as well as **c**—*Fa* of the triple scale, as well as *Se* of the double. In the fifth measure the fourth note may be the same C, and the sixth note may be e, the sixth or *la* of the triple scale of G. But the following note on the same degree in the sixth measure is clearly and necessarily E, Re, or the ninth of the chord of the seventh on D. So the third note of the first measure may be e. The enharmonic change from e to E, a rise of a comma, is often required, is very beautiful, and I have proved that it can readily be made for my singers, who know this change of a comma as well as others know the tone or semitone, will give it, even without accompaniment, with perfect accuracy, as proved by the harmony afterward applied as a test. All this variety within the limits of musical laws—which only forbid what is disorderly, complicated, or what the ear will not distinguish—adds to the pleasure of music, and it is the exact rendering of all the melodies and harmonies which gives the charm to a good singer. When acutely perceptive of such accuracy, I had the good fortune to listen to Alboni on all the occasions when it was possible to do so. I thought her then, and still am of the opinion, that she was the best singer I have ever heard. It is certain that she had a wonderful exactness in executing whatever she undertook. There was no "temperament" in *her* scales, and what the strictest theory requires in intonation she understood and gave. She sang music whose analysis would alarm a student with its apparent difficulties; but the delighted auditors perceived only a delicious and "easy" flow of melody.

10. Fortunately, the greater part of the difficulties in the higher class of melodies are overcome by the unconscious or instinctive talent of the singers. The accompaniment of such melodies is not difficult, and the harmonies attending make clear what the melody must be. No instrument will ever compete with the voice in its peculiar department, but may surpass it in that which it is fitted for. Neither voices nor instruments separately can produce the highest effects in music; those will be attained by the combination of the two. Improvement in the

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* Generally so called. It is the air in Mozart's *Il Flauto Magico,* "*Oh! cara armonia.*" From this is taken the song "Away with melancholy."

instruments which accompany will be followed by better vocal music.

11. For understanding what is to follow, I would have it borne in mind, that I consider that all musical ratios derived from the primes 3, 5, and 7 are appreciable by the ear, and may be used in all their combinations and transpositions into different keys, which is already done in a series of perfect fifths. The next prime, the eleventh, does not present sufficient claims to be admitted to the musical canon, except under regulations which as yet I would not undertake to define. I can tune it, and can perceive that it yields harmony so far as to give coincidences in its vibrations with the other prime chords, the fifth, the third and the seventh. It is not impossible, when a great refinement is made in music, and the sense highly cultivated, that this class of novel sounds may be introduced and appreciated. But except under such conditions, and without the most exact intonation, the eleventh would fail to give any effect other than incomprehensible discord. It might be admissible in the harmonic stops of an organ—those called mixtures, sesquialtras, etc.—but only under a system of perfect harmony.

12. For a practical instrument I would provide five series of sounds—a series signifying that each sound is a fifth from that which precedes, and that which follows it. These five series, arranged in the order of their importance, are as follows, the notes of each series being marked with the letter and sharp or flat in common use, but in a distinctive type for each series:

Series I.	Key-Notes.	Roman capitals, A, B.
" II.	Thirds (major) to key-notes, series I,	Roman lower-case, a, b.
" III.	Perfect sevenths to key-notes, " I,	Gothic capitals, **A**, **B**.
	(These constitute the major scales.)	
" IV.	Dominant thirds (major), in the minor mode, being major thirds to II,	Italic lower-case, *a*, *b*.
" V.	Dominant sevenths, in the minor mode, being perfect sevenths to II,	Gothic lower-case, **a**, **b**.
	(These two last complete the minor mode.)	

13. This being understood, it will be known that the same letter in the same type is always the same sound, and its relation evident; that the same letter in Roman lower-case is a comma lower than the same in capitals, and a quarter (0·256) of a comma higher than the seventh in Gothic capitals. A letter of the III series, in Italics, is two commas below the same in the I series, or one comma below that of the II. The sevenths of the V are one comma below those of the III; the lower-case letter indicating this difference below the capital.

14. Among the names which have to be remembered as advocates of perfect harmony and just ideas in music, perhaps the first in modern times is that of Gen. T. Perronet Thompson of

London. My first knowledge of his valuable services came during the preparation of the second part of my article in this Journal (in March, 1850), by an allusion in the Westminster Review to an enharmonic organ which he had just brought out in London. This led to the reading of his spirited articles on music and other subjects in the Westminster Review, and to the seeking his acquaintance, which, through a considerable correspondence, I have had the good fortune to make. I have also received his "*Theory and Practice of Just Intonation*" and "*Description and use of the Enharmonic Organ*" of his invention, "*built for the Exhibition of* 1851, *and an Appendix tracing the identity of design with the Enharmonic of the Ancients.* London, 1850." 8vo. I also obtained, after much search, and by the kind efforts of the author, what appears to be the initiative work of Gen. Thompson in musical doctrines. Although a work requiring thorough classical and mathematical knowledge, as well as information in several departments of literature and taste, it bears the modest title, "*Instructions to my Daughter for Playing on the Enharmonic Guitar, being an attempt to effect the execution of correct harmony, on principles analogous to those of the ancient Enharmonic. By a Member of the University of Cambridge. London*, 1829." In folio, with illustrations. This work seems to have been stimulated by a fine perception of the delicate harmonies of which the guitar strings are capable, and by falling upon the collection of the "Seven Ancient Greek authors on Music," collected and published by Meibomius, and printed on the Elzevir press in 1652, a copy of which is in the library of Harvard College. The Euclid of geometry is one of these seven, and there is an eighth author who is not reckoned an ancient, as he lived as late as A.D. 470. It is clear that there was something which these called "*enharmonic*," which is declared to be the "*most accurate*." (Aristides Quintilianus, lib. i, p. 19, ed. Meib.) That "the name of enharmonic [or harmony] is given to the genus abounding in the smallest intervals; from the harmonizing." (Idem, i, 18.) "The enharmonic, so called from being taken in the perfect intervalling of whatever is subjected to harmony." (Id., ii, 111.) With much more to justify Gen. Thompson in adopting the title of Enharmonic: which name I also take as appropriate to a system of perfect harmony, and to the instruments which are constructed on its principles.

15. The enharmonic organ of Gen. Thompson had key-boards in which, without any change in the interior of the organ, all sounds contained therein could be given. Every sound of the organ was represented in three key-boards, except some very rarely called for, which had exchangeable pipes. The organ of Mr. Alley and myself had a key-board like that of the common organs, and the fingering was the same: all changes were made

by pedals, one for each key, which put the organ in tune for its own scales. It could be played without the player knowing what sounds he used—he only needed to keep the organ in the right key. Gen. Thompson justly remarks that his system would have merits over ours, in compelling a musician to know what he is doing. But in the dark days of enharmonic science it may be excusable not to demand too much of the organists.

16. There are great difficulties which present themselves in admitting to a key-board the multitude of sounds required if several transpositions or signatures are to be played in. If the five series of sounds already described, § 12, are carried into the keys from nine flats to nine sharps—nineteen signatures—just one hundred notes to the octave are required! But an octave is limited in width by the span of the fingers. Six and a half inches is about the convenient average measure, and this is adopted by organ and piano-forte makers. If the notes we want are divided equally into this space each will get the hundredth part of it, or sixty-five thousandths of an inch. The pins of a barrel organ might play upon them, but with human fingers it is hardly possible.

17. But there is a fortunate circumstance in the relation of the sounds which comes to our aid. All are not wanted at the same time; when we are near the key of nine sharps there is no possibility of our requiring the notes of nine flats. These we may arrange therefore at a distance front or back, and place near by the related notes which may be required in connection with those already in use.

18. At least seven finger-keys should be in convenient relation to each other, and of sufficient size and position to allow of their being touched, and for the changes of fingers necessary in running scales and taking chords in different positions. Such a key-board I have endeavored to devise, the result of which may be seen from the following description and figures.*

19. The first point I took in the resolution of the problem was, the convenience of the broad white ivory keys of the common key-board, and the elevated black keys—the white especially affording room for shifting the fingers, and the raised keys making it easy to touch a narrow key, which it would be hard to do if all were in one level. The second: that the key-notes and the thirds, being of different classes, might be assigned to these two classes of finger-keys, naturally giving to the first class the more extended keys, or the white. So the octave ought to have its seven notes. Pieces of bristol board were cut to the width of the common white keys, or nearly an inch, and in length double that of the part in front of the black keys.

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* At the time of writing (April, 1867) I have made application for a patent for this key-board.

With the same material I made elevated black keys of the width and height of those of the common key-board, and of the length of 2·7 inches, which were arranged in hopes of getting at least the diatonic scales, triple and double, which could be easily managed, and in a manner uniform for all keys.

20. This provisional key-board is not figured here, but may be understood by reference to figs. 1, 2 and 3, which contain also the additional series of sounds, IV and V, § 12. In fig. 1 let the black key, d, be moved to the left until its left edge coincides with the right edge of C, its back end as now being in contact with the front end of the white key D; let e, f♯, and the two keys ($\mathbf{F}^7$ and another not marked but really $\mathbf{E}\flat^7$) marked with vertical lines indicating their color, red, be moved in the same direction and distance as d, till they are in contact, respectively, with D and E. There is no room now for *d*♯ and $\mathbf{d}^7$ and their two companions by f♯, but we have all the key-notes, thirds and perfect sevenths, and the advantage of greater width in the white keys, which are nearly an inch and a quarter wide (1·21 in., the black keys being 0·45). This key-board, although deficient in the minor mode, from the absence of the series IV and V, is still recommendable where economy is necessary, as all the music of the major key, including the beautiful chord of the seventh, can be played; except in cases where certain accidentals are introduced from the minor mode, as illustrated in the example from Rossini in § 8.

21. A portion of the complete enharmonic key-board is shown in perspective in fig. 1, in the natural size—the length of the keys being reduced to one-half by the perspective. The keys are of five different colors—represented here, the white and black by their natural colors, and the rest according to heraldic rules, viz., the *red* by vertical lines, the *blue* by horizontal, and the *yellow* by white stippled with black—and of as many different elevations. The following table represents this.

Series.	Color.	Elevation.	Example.
I. Key-notes,	white	0·0	C, D
II. Thirds,	black	0·4 in.	b, e
III. Sevenths,	red	0·05 "	$\mathbf{F}^7$
IV. Dom. 3ds, minor,	blue	0·10 "	*d*♯
V. Dom. 7ths, minor,	yellow	0·15 "	$\mathbf{d}^7$

22. These keys all have vertical rectilinear motion so that a touch on any part of their surface produces always the same effect. This is attained—in one method—by attaching each to a pair of guiding rods, passing down through a couple of horizontal tables where they are secured to a piece which communi-

cates in the usual manner with the valves or hammers. It will be understood that the mechanical construction of the instrument beyond the key-board may be the same as usual, except that its *number* of pipes or strings must be multiplied.

23. As the assemblage of all the notes may confuse the eye at first sight, I have drawn on half scale the plan of the finger-keys which in *every signature*—or commencing on any white key whatever—give the triple and double diatonic scales. The white keys are of the width of 0·993 in., the black keys having the width of 0·45.* The white keys on the common key-board are but 0·93, or the seventh of 6½ inches. The plan in fig. 2 will enable a player to judge whether the scale can be executed. It is immediately intelligible even to a child, who, having learned the order in one key, knows it in every other. The keys are considered by their relations to each other, that is, as Do, Re, etc., and (to repeat it again), Do may be taken on any white key. The fingering in the triple diatonic scale is the same as in that of the natural key, and of others, on the common key-board, and the fingers easily reach the keys and change on Fa and Do as in the latter case. In the following scales the usual signs represent the thumb and four fingers; see fig. 2.

TRIPLE DIATONIC SCALE—*Its fingering.*

Do	Re	mi	Fa	Sol	la	si	Do
+	1	2	+	1	2	3	4 (or +)

DOUBLE DIATONIC SCALE—*Its fingering.*

Fa	Sol	la	**Se**	Do	Re	mi	Fa
+	1	2	3	+	1	2	3

The player is recommended to complete the octave, Fa to Fa, by copying the four lower keys, Do, Re, mi, Fa, figs. 2, 3, and placing the lower Do upon the upper one, or by conceiving that this has been done. This will show the double scale in its regular order.

24. I regret that the limits of these pages did not allow a larger portion of the key-board, and permit reference to it in the manner of taking the several chords in their various positions. But I think that those interested can extend the diagrams by the data given, and I shall, therefore, give the fingering for several chords, which being understood in one key will be the same in all transpositions.

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* The widths are established thus: first determine the width of the octave, and that of the black keys. Representing these respectively by O, and b, the width of the white key (W), is obtained thus: $\frac{O+b}{7}=W$. For the key-board for major keys, only, § 20, the formula is $\frac{O-b}{6}=W$.

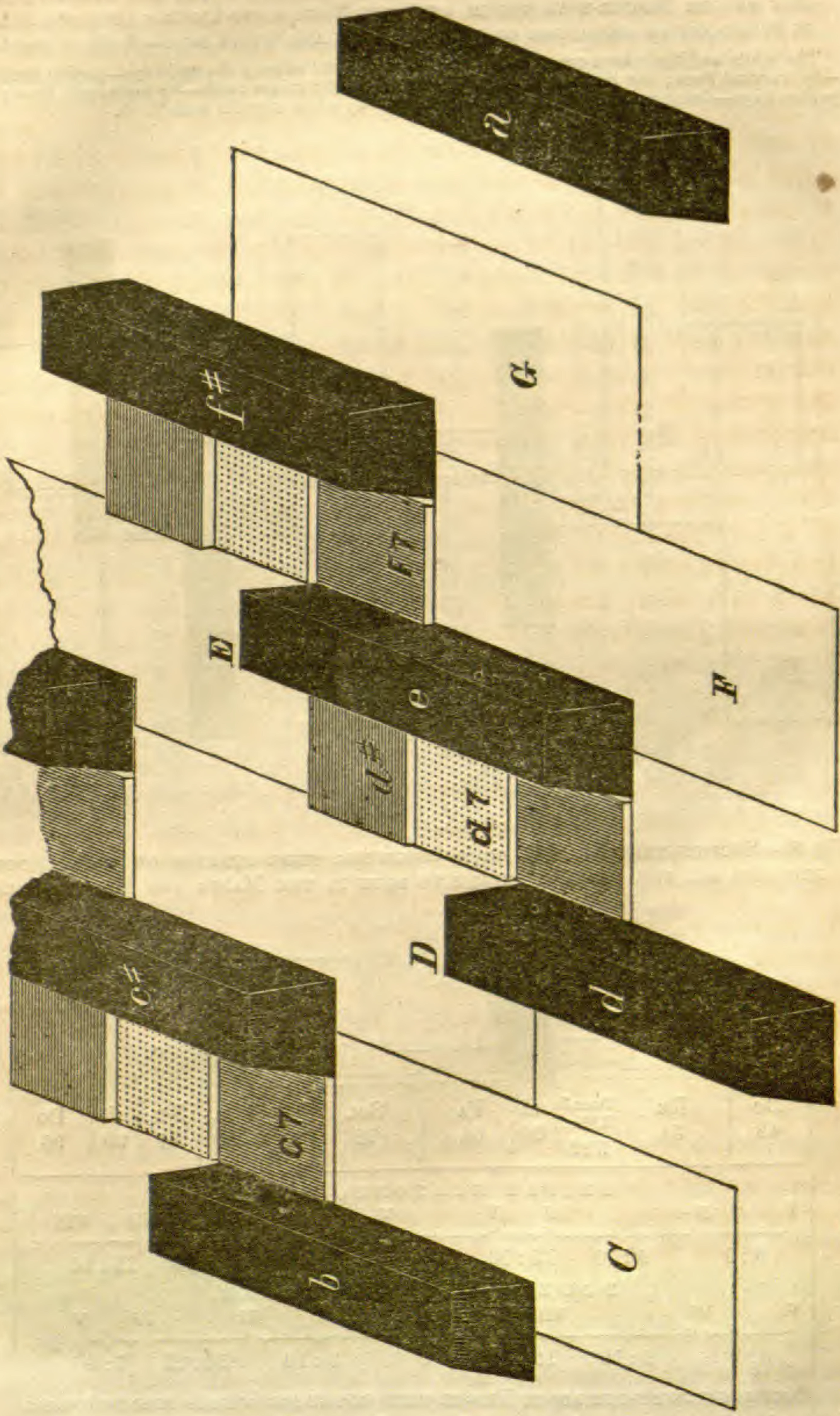

Fig. 1.—ENHARMONIC KEY-BOARD.

Fig. 2.—A PORTION OF THE ENHARMONIC KEY-BOARD, SHOWING THE RELATIVE POSITION OF THE FINGER-KEYS WHICH GIVE THE TRIPLE AND DOUBLE DIATONIC SCALES IN EVERY KEY OR SIGNATURE, OR TAKING DO ON ANY WHITE KEY.—*Scale of one-half.*

The white and black keys are represented in their natural colors; the red keys—perfect sevenths—by vertical lines; the blue keys—dominant thirds in the minor mode—by horizontal lines; the yellow keys—dominant sevenths in the minor mode—by white stippled with black.

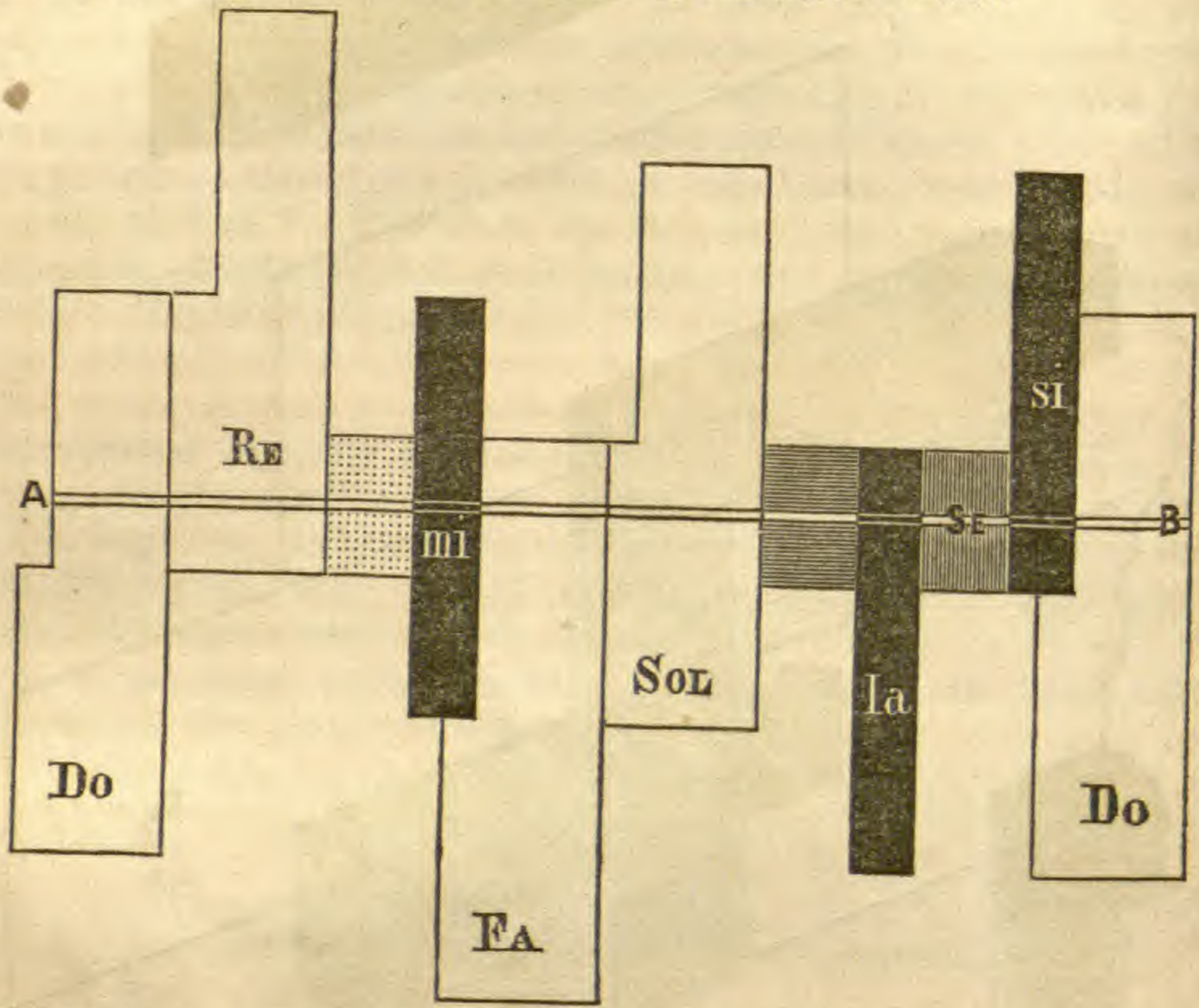

Fig. 3.—SECTION THROUGH A B, OR THROUGH THE THIRD QUARTER OF ANY KEY-NOTE, EXPOSING ALL THE NOTES OF THAT KEY BOTH IN THE MAJOR AND MINOR MODES.

Do 48	Re 54	Dom.7 R.Min. 52·5	mi 60	Fa 64	Sol 72	Dom.3 R.Min. 75	la 80	**Se** 84	si 90	Do 96

TRIPLE DIATONIC SCALE.

I II III IV V VI VII VIII

8 : 9 9 : 10 15 : 16 8 : 9 9 : 10 8 : 9 15 : 16

DOUBLE DIATONIC SCALE.

V VI VII I II III IV V

8 : 9 9 : 10 15 : 16 8 : 9 9 : 10 20 : 21 7 : 8

SOUNDS GIVEN BY THE ABOVE FINGER-KEYS IN THE SIGNATURES CORRESPONDING.

1♯	G	A	**a**^{7}	b	C	D	*d*♯	e	**F**^{7}	f♯	G
♮	C	D	**d**^{7}	e	F	G	*g*♯	a	**B**♭^{7}	b	C
1♭	F	G	**g**^{7}	a	B♭	C	*c*♯	d	**E**♭^{7}	e	F

A For extended Table see next page—Enharmonic Table. A

ENHARMONIC TABLE,

COMPRISING THE NOTES GIVEN BY THE SECTION A B, FIGS. 2, 3, IN THE SIGNATURES FROM 9 FLATS TO 9 SHARPS, AND CONTAINING THEIR DIATONIC SCALES, INCLUDING THE MINOR MODE. 100 NOTES TO THE OCTAVE.*

	TRIPLE DIATONIC SCALE.										
Signature.	Do	RE		mi	FA	SOL		la		si	Do
	KEY-NOTE.	SECOND.		3d.	FOURTH	FIFTH.		6th		7th.	OCTAVE.
9♯	D♯	E♯	**e♯**^{7}	f×	G♯	A♯	*a*×	b♯	**C♯**^{7}	c×	D♯
8♯	G♯	A♯	**a♯**^{7}	b♯	C♯	D♯	*d*×	e♯	**F♯**^{7}	f×	G♯
7♯	C♯	D♯	**d♯**^{7}	e♯	F♯	G♯	*g*×	a♯	**B**^{7}	b♯	C♯
6♯	F♯	G♯	**g♯**^{7}	a♯	B	C♯	*c*×	d♯	**E**^{7}	e♯	F♯
5♯	B	C♯	**c♯**^{7}	d♯	E	F♯	*f*×	g♯	**A**^{7}	a♯	B
4♯	E	F♯	**f♯**^{7}	g♯	A	B	*b*♯	c♯	**D**^{7}	d♯	E
3♯	A	B	**b**^{7}	c♯	D	E	*e*♯	f♯	**G**^{7}	g♯	A
2♯	D	E	**e**^{7}	f♯	G	A	*a*♯	b	**C**^{7}	c♯	D
1♯	G	A	**a**^{7}	b	C	D	*d*♯	e	**F**^{7}	f♯	G
♮	C	D	**d**^{7}	e	F	G	*g*♯	a	**B♭**^{7}	b	C
1♭	F	G	**g**^{7}	a	B♭	C	*c*♯	d	**E♭**^{7}	e	F
2♭	B♭	C	**c**^{7}	d	E♭	F	*f*♯	g	**A♭**^{7}	a	B♭
3♭	E♭	F	**f**^{7}	g	A♭	B♭	*b*	c	**D♭**^{7}	d	E♭
4♭	A♭	B♭	**b♭**^{7}	c	D♭	E♭	*e*	f	**G♭**^{7}	g	A♭
5♭	D♭	E♭	**e♭**^{7}	f	G♭	A♭	*a*	b♭	**C♭**^{7}	c	D♭
6♭	G♭	A♭	**a♭**^{7}	b♭	C♭	D♭	*d*	e♭	**F♭**^{7}	f	G♭
7♭	C♭	D♭	**d♭**^{7}	e♭	F♭	G♭	*g*	a♭	**B♭♭**^{7}	b♭	C♭
8♭	F♭	G♭	**g♭**^{7}	a♭	B♭♭	C♭	*c*	d♭	**E♭♭**^{7}	e♭	F♭
9♭	B♭♭	C♭	**c♭**^{7}	d♭	E♭♭	F♭	*f*	g♭	**A♭♭**^{7}	a♭	B♭♭
	FIFTH.	SIXTH.		7th.	KEY-NOTE.	SECOND.		3rd	**4th**		FIFTH.
	Do	RE		mi	FA	SOL		la	**Se**		Do
	DOUBLE DIATONIC SCALE.										

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* In considering the relation of the notes in the enharmonic system, there is constant reference to the series of fifths, and the following observation of their order may be of use. A descending series of fifths is a succession of the following letters, the first four of which form an English word, viz., *bead gcf*. When the series is extended down, a flat is added, always on the beginning of this series or on *b*, which sign continues without change to *f*, where another flat comes in, remaining also for the seven letters. If the series commences with one or more sharps, the same rule holds good, remembering that a sharped note is flatted by making it natural. If then we commence with B♯ we shall have

B♯, E♯, A♯, D♯, G♯, C , F♯—B, E, A, D, G, C, F—B♭, E♭, A♭, D♭, G♭, C♭, F♭,

or the key-notes of the keys from twelve sharps to eight flats. Continuing, we should have a succession of the same letters, with double flats, ending with the key-note of fifteen flats; next the same with triple flats, leaving us in the unexplored regions of twenty-two flats, where for the present we will stop. The series of thirds, sevenths, etc., follow the same succession.

To the perfect sevenths is added the index ⁷, not as being essential, for the type alone is sufficient to distinguish them, but in order to make them more conspicuous at the present time.

Examples in Fingering Chords on the Enharmonic Key-board.

NOTES.—*a*, subdominant chord, f and a; *b*, dominant with seventh, **F**^{7}; *c*, same with ninth, A; *d*, dominant seventh; *e*, dominant of relative minor; the seventh, **d**^{7} may be added; *f*, subdominant with seventh; *g*, grave second d, or sixth of subdominant. The flatted note should be made natural in the next chord.

The double figures indicate that the key is touched with one finger, which is immediately changed for another, as is customary in passing smoothly from one chord to another. The base will be easily supplied by the musician, who will also observe the similarity between this fingering, and that of the common key-board.

25. The chords given belong in part to the triple, and in part to the double diatonic scales, or more properly speaking, those scales belong to these chords. For melodies originate from harmonies, if either can be said to generate the other, when both spring into existence almost at once. When Haydn, who from poverty could not obtain instruction in the theory of music, was forced to search for himself, he discovered certain rules which he was desired to impart. "Try to find them out," is understood to have been his sensible reply. It was supposed that they referred to the dependence of melody on harmony. However this may be, it is certain by the evidence contained in his compositions, that he had a very complete and delicate knowledge of the laws of harmony and their relation to melody, and that his inspiration came from a higher source than the tempered octave of twelve keys. The student who would follow Haydn's advice will find more aid in an enharmonic key-board with its pipes, strings, or even seraphine reeds, than in the most thorough primer of thorough-base that has yet been published. A pupil in harmony taught by an instrument tempered with twelve sounds is worse off than a student of mineralogy shut up with twelve specimens, or of chemistry with so many elementary substances. The latter might learn much that is true and important, and so might the musical student would he tune his twelve notes accurately to something. And I would not be understood as thinking that those thus taught harmony are totally ignorant of its true principles; I have met with notable instances where the truth was denied in words and declared in actions. Musi-

cians sometimes learn by intuition, and contrary to what they are taught. So people are found just and amiable in spite of bad political or theological creeds and education.

26. Fig. 3 gives a section through the center of the third quarter of the key-note of fig. 2, and through all the notes, major and minor, of the signature to which it corresponds. The circumstance that a section in this place will cut all these notes and no others, might be considered remarkable and even wonderful, were it not for the fact that *this is the first principle on which the system is based.* In constructing the board a certain number of parallel spaces are laid down from left to right, and one space is assigned to each signature intended to be provided for. In the natural signature, C, the key-note, has its place of necessity. But C is the fourth of 1♯ and accordingly is prolonged backward,—toward what would be the top of a page or the north point of a map—over the space of 1♯. As it is the fifth of 1♭, and the second of 2♭, it is brought forward to cover the spaces of these two signatures also, and the whole key now is four times as long as the space originally assigned to each signature—which I have taken at nine-tenths of an inch, but which might have been more or less. So every other note wanted in a signature is placed here, and if wanted in adjoining ones it is protracted into them. Thus the e of the natural key is in all the spaces occupied by its root C, except in that of 2♭, where it is not used. The perfect sevenths and dominant thirds and sevenths of the minors being used each in one signature only, are not extended beyond it. Many simple rules for the relative position of the finger-keys could be given, which quickly fix their location in the mind, like the following:

27. *Rules.*—1. From the back half of a white key to the adjoining white key, on the right, is a *major tone,* 8 : 9, e. g., Do to Re, fig. 2, C to D, fig. 1, and *vice versâ.* 2. From the front half of a white key to the nearest black key, on the right, is a *minor tone,* 9 : 10; e. g., Re to mi, fig. 2, D to e, fig. 1, and *vice versâ.* 3. From the forward part of any black key to the adjoining white key into which it is half inserted, on the right, is a diatonic semitone, 15 : 16; e. g., mi to Fa, fig. 2, e to F, fig. 1, and *vice versâ.* 4. From the back end of any black key to the next black key on the right, is a *major tone;* e. g., la to si, fig. 2, e to f♯, fig. 1, and *vice versâ.* The distance to the right, or left, for whole tones is always the same, viz., the width of the white key or 0·993 in. Other rules will suggest themselves to the student, and these specimens will suffice.

28. The finger-keys supposed to be cut by the section A B, have their remaining portion in the rear, shown in perspective, and are marked with their names and the relative vibrations of their sounds. Below is indicated their order in the triple and

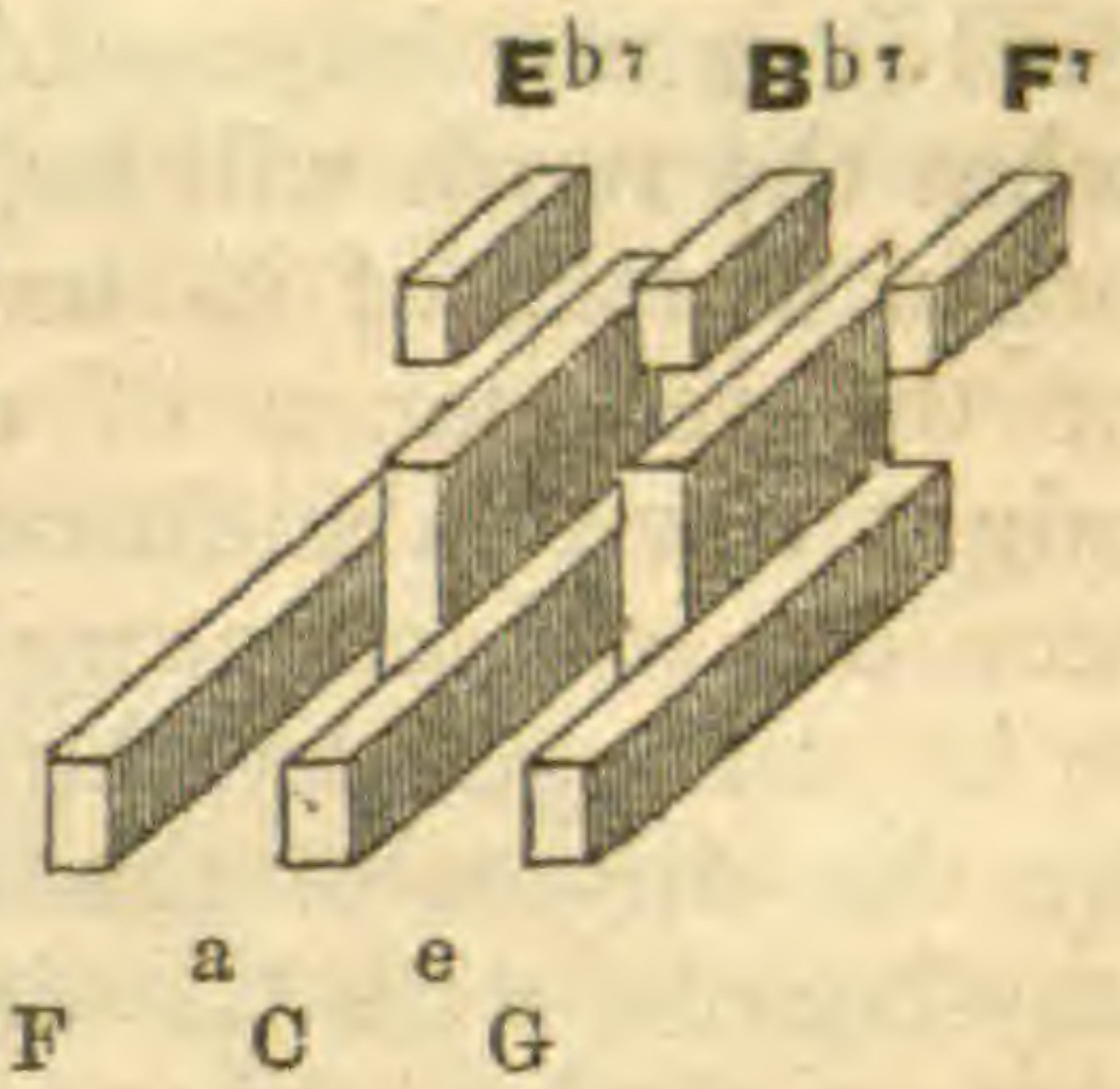
double diatonic scales. Still below is a part of a table of the fixed notes which would be cut were this section made through the key-note of the several signatures indicated in the margin. The complete table should follow below this section, but as the space of the page does not allow, it is given entire on the opposite page, and should be referred to this section; even the width of the paper on which the sounds are marked corresponds with that of the finger-key in the place it is supposed to have been cut. This enharmonic table contains in its eleven columns all the notes of the major and minor modes, within the limits of nine flats to nine sharps, both inclusive, and comprises one hundred notes to the octave. Owing, however, to the close coincidence of two of the series with two others, twenty-two of these can be dispensed with without an error exceeding the hundredth of a comma in the fifths alone, and nothing elsewhere; which difference may be neglected, and is, practically, through the "sympathy" of accordant sounds, in perfect tune.

29. The last named circumstance is of much importance when the cost of organ-pipes is in question. Although there is no such thing in music as a "circle" of keys returning into itself theoretically and mathematically, yet there are certain close approximations which can be taken advantage of for economical reasons. If we ascend eight perfect fifths and a major third, and descend five octaves, we have a note higher than our starting pitch by something less than the eleventh of a comma, or in the relation of its vibrations to the starting pitch as 100,111 to 100,000. This supposes absolutely exact tuning, which is very difficult, as the pipes or strings, when near the sound they would give when sounded singly, draw into tune, and are perfectly accordant. So that if the tuner should make his fifths one-fiftieth of a comma flat—which he might do and have them all sounding in perfect tune—he would end as much below the starting pitch as perfect tuning should, theoretically, bring him above it. From which it is seen that he can, if he choose, flat each fifth one hundredth of comma and the two series will then coincide. Indeed, this distant note is useful as a landmark, and as a detective of small errors accumulating among so many fifths. It may be compared to the correction of measured distances by astronomical observations, without, like the latter, being subject to any errors of observation however small.

30. On reference to the table, page 13, two notes thus approximate are C in the natural key and b♯, the third of eight sharps. And the key-notes B♭♭, 9 flats, to G, 1 sharp, are thus available for the thirds, from a, in 1 flat to f×, in 9 sharps; in all eleven pipes saved. Also the thirds, d♭, in 9 flats, to b, in one sharp, are equally serviceable for the dominant thirds in the minor mode, *c♯* in 1 flat to *a×* in 9 sharps, which include eleven more pipes, reducing the hundred of the table to seventy-eight only.

31. With the key-board that has been described, all the playing is done with the hands, without aid from the feet, and there is nothing to prevent the use of the feet for pedal bases. But the same key-board is not best for fingers and for feet, especially with the large number of its sounds, many of which are not called for in pedal bases, while others are constantly required. I have therefore devised an *enharmonic pedal key-board* which is sufficient and convenient for the pedal parts. The notes most needed are the key-notes. These are arranged in front in a straight line and in the order of the fifths ascending from left to right. Behind these and in a higher row and between the key-notes are the major thirds of the keys in front and to the left of each. Still above the thirds, and directly behind the key-notes, are the perfect sevenths of the latter. The key-notes are white, the thirds black, and the sevenths red, as in the manuals. Each pedal is an inch wide and two and a half inches from center to center apart. The arrangement of the notes in the three series is as in the fig. 4, and in the following sketch:

Fig. 4.—Enharmonic Pedal Key-board.



Order of the Pedal notes.

F$^{\flat 7}$ C$^{\flat 7}$ G$^{\flat 7}$ D$^{\flat 7}$ A$^{\flat 7}$ E$^{\flat 7}$ B$^{\flat 7}$ F^{7} C^{7} G^{7} D^{7} A^{7} E^{7} B^{7}
Sevenths.

b$^{\flat}$ f c g d a e b f♯ c♯ g♯ d♯ a♯
Thirds.

G$^{\flat}$ D$^{\flat}$ A$^{\flat}$ E$^{\flat}$ B$^{\flat}$ F C G D A E B F♯ C♯
Key-notes.

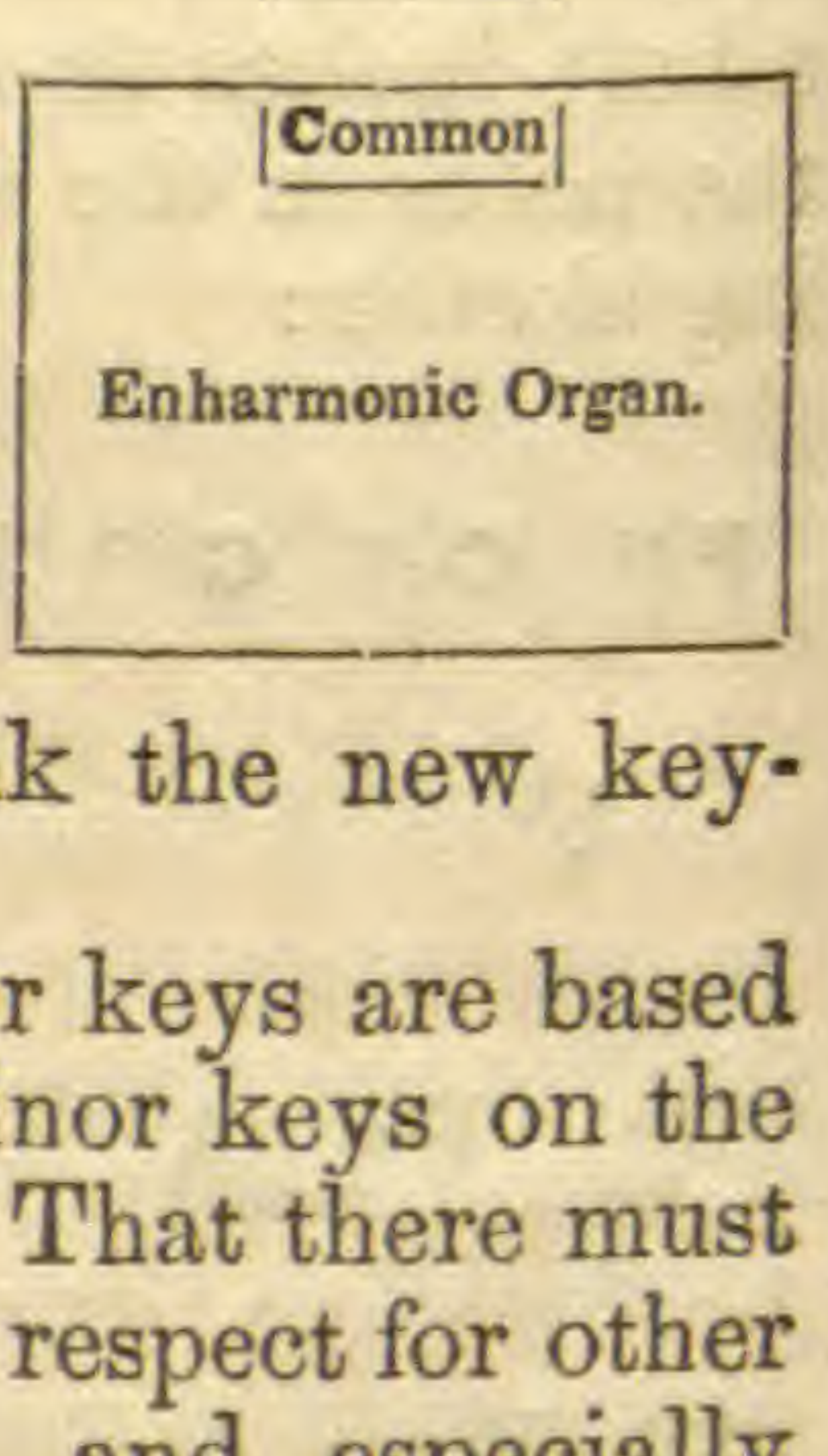
32. The most important notes of a pedal base, after the key-note, are the fifth above and below; these are found here on the right and left of the key-note. The third—in the second row—is on the right of its key-note, and the tonic of the relative minor on the left. So with the relative minor: its dominant is on its right as in the major scale. If a base requires the common chord in successive notes, or in *arpeggio*, they come easily thus (Ex. 1), the keys being all together. The chord of the seventh is taken thus (Ex. 2). The diatonic scales may be played in their melodic order, Do, Re, mi, etc., without having to skip farther than the second key above or below, or a distance of five inches. Further capabilities in this key-board will appear as it is studied.

Ex. 1.
mi
Do Sol

Ex. 2.
Se
mi
Do Sol

33. Consequently, there is equal facility as in the tempered organs for managing the pedals, for the swell organ, for bringing on and taking off the stops, etc. Without considering that difficulty should stand in the way of accomplishing a desirable object which is possible and worth the expense, I would submit to those interested that it is practicable to manage an organ constructed on the principles I have proposed, and that it would give general satisfaction to the lovers of music—nearly the whole civilized world—to listen to it. I consider that the only great difficulty is in getting the requisite money applied to its cost. Still it is not impossible that some one who believes, or *knows*, what the result will be, will some time be able to build a great organ worthy of its name. If it will help its success—in view of the reluctance of organists to learn a new key-board—it might have, in addition to the enharmonic key-board, the common one with selecting apparatus, like that of the organ of 1849, to be managed by the feet of the organist, or by the fingers of the director. One of these key-boards, with the draw-stops and all necessary might be in front of the organ, facing forward, and the organist by turning on his seat could play on either, or another player could play at the same time.

ORGAN WITH TWO KEY-BOARDS, ENHARMONIC AND COMMON.



34. I propose to add to my organ—which now has the common key-board and transposition pedals—the enharmonic key-board; which will then be as represented here. But I think the new key-board alone sufficient.

35. In the theory I have advocated, the major keys are based on the first series of sounds (§ 12), and the minor keys on the sixths of the major keys, or on the series II. That there must be such a relation and order is inevitable. But respect for other authorities—among them Rev. Henry Liston, and especially Gen. T. Perronet Thompson—make it proper to mention that the major key of E may be taken on e, the third of the natural key; and that of the minor key on c, which I have assigned to the signature of three flats, may be taken on C, with the natural signature. Indeed, Mr. Liston in his organ of 1810, and Gen. Thompson in his of 1850, have this arrangement.[*] Musicians must decide upon the utility of taking the minor key of c upon the key-note of C major, or the scale of A♭ major with C of the

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[*] The three key-boards of Gen. Thompson's organ give respectively the keys of C, e, and d: the scale of 4♯ being based on e, the third of the natural scale, and that of 2♯ on d, the sixth of 1♭, instead of on D, the second of the scale of C. The key-notes, D and A, their thirds, f♯ and c♯, and fifths, A and E, are given; but here this series of fifths ends. B and g♯ are not embraced in the forty-two notes of his octave, in which all are employed in thirds and fifths, and none for the perfect sevenths.

natural scale as its third. If this is desirable, I have provided a finger-key at the back end of each black key, giving the minor third to the key-note, to which this black key gives the major third. For example, at the end of the key e, is **E♭**, minor third to C. This key is on a vertical wire with a circular head rising above the black key; and the whole key can be removed, if found to be in the way when not wanted. The sound, if introduced, will form a series VI (§ 12), and will require but eight extra organ pipes, whatever the number of signatures. The key-note of the ninth signature above, is but 0·09 of comma sharp for a minor third; but applying the correction (§ 30) needed for other notes, these minor thirds are made mathematically perfect. Thus the key-notes (see enharmonic table, p. 13,) C to D♯, become the series **D♭♭** to **E♭** (series VI, § 12), minor thirds respectively above the key-notes B♭♭ to C.

36. By transposing a scale by fifths, above or below, we first obtain a pitch widely different, and afterward approach that from which we started. For example, beginning with C we have G far removed, but in the next transposition comes D, only one diatonic interval—the tone—above C. Proceeding in the same direction, we shall ascend until at the seventh step we reach C♯, a large chromatic semitone above C. At twelve sharps B♯ is reached above C by what is called the comma of Pythagoras, or 1·09252 comma. This is the "*circle*" of the equal temperament, where the tuner divides this excess among the 12 fifths: making tolerable fifths, but intolerable substitutes for thirds. With twelve other notes for thirds, fair intervals could be had. At each successive twelve transpositions we rise by the same comma, until at fifty-three sharps the key-note is closer than ever to the starting pitch—only 0·16813 of comma sharp. If this small interval is divided among the 53 fifths, leaving each flat 0·00316 of comma, the circle will meet, and the octave will be divided into 53 equal intervals.* These are nearly exact for all the combinations of the triple diatonic scale, in these 53 keys. The fifths are as stated. The major thirds are 0·065 of comma sharp—near the limit where they draw into tune by "sympathy." In equal temperament they are sharp 0·63582.

37. The following table, page 21, serves to show: 1. this equal

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* This is most readily done by its logarithm, viz., 0·00567,98112,38943,04142; which, added to itself 53 times, gives the log. of the octave, 2 : 1.

It is related that Mr. Briggs, in constructing his logarithms, in order to find the first small number, began with the number 10, and its logarithm 1, and extracted continually the root of the last number, and bisected its logarithm, till he arrived at the 53d and 54th roots and their annexed logarithms as here below: where he found that the decimals in the natural numbers are to each other in the ratio of the logarithms, or as 2 : 1.

	Numbers.	Logarithms.
53	1·00000,00000,00000,25563,82986,40064,70	0·00000,00000,00000,11102,23024,62515,65404
54	1·00000,00000,00000,12781,91493,20032,35	0·00000,00000,00000,05551,11512,31257,82702

division into 53 notes, and how each division serves for six different notes in such close approximation that the eye would take them as one; 2. the perfectly tuned notes in their order as regards acuteness of pitch; as they result from successive transpositions by sharps and by flats to the 53d degree: and 3. any other adjustment in order to economize in the number of organ-pipes.

38. If the ear is content with the thirds 0·065 of comma sharp, we can have 53 signatures in sharps, and as many in flats—106 keys—complete in all except the perfect sevenths: these will all be supplied by 53 other pipes, making 106 pipes in the octave for what mathematically requires 640.

39. But there is an arrangement by which we can have perfect thirds and all other intervals. By flatting the fifths 0·0113 of comma, as described in § 30, and adding eight pipes, we have the triple diatonic scale perfect in 53 signatures, with 61 pipes. The perfect sevenths are supplied, and the double diatonic scales completed, by 53 additional pipes. For the minor mode we require 8 pipes each for the dominant thirds and sevenths; making a total of 130 to the octave for 53 keys absolutely perfect. They can be taken above or below the natural signature, as from 26 flats to 26 sharps: or in any other connected series of signatures. We should not have the circle joining exactly, § 36, but we should have perfect intervals within these wide limits. An enharmonic key-board for 53 signatures, on the scale I have drawn, would require about four feet of width, which could be divided into two or three boards.

40. Other adjustments can be made which are favored by the closeness of the intervals, and the large range within which the differences can be divided. In a temperament of 12 sounds, the grand difficulty is to dispose of a comma among 5 intervals, viz., 4 fifths and a major third—ignoring the chord of the seventh. The third of C, e, must serve for E. In any system the sum of the errors in these 5 intervals is always exactly a comma. The mean-tone temperament gives it all to the fifths, one-fourth of a comma each, and the equal temperament, dividing but one-twelfth to each fifth, leaves the third sharp by two-thirds of a comma. Here we have a difference of only one eleventh of a comma, and have 8 fifths among which to divide it.

41. The following table gives the names of the key-notes of 106 regular transpositions by fifths, according to common musical rules, and the number of sharps or flats in the signature of each. It gives, besides, the thirds and dominant thirds of the minor mode which are closely approximate to the key-notes, together with the signature in which each note of the two latter series is found. A column of figures ascending from 1 to 54 indicates that there are so many notes arranged in the order of

DIVISION OF THE OCTAVE INTO 53 INTERVALS.

		Transposition by Sharps.						Transposition by Flats.					
		Key-notes.		Thirds.		Dom. 3ds. Rel. Minor.		Key-notes.		Thirds.		Dom. 3ds. Rel. Minor.	
		♯s in Sig.	Letters. Times sharped.	♯s in Sig.	Letters. Times sharped.	♯s in Sig.	Letters. Times sharped.	♭s in Sig.	Letters. Times flatted.	♭s in Sig.	Letters. Times flatted.	♭s in Sig.	Letters. " " flatted.
Octave, 2 : 1.	**54**	0	C 0♯	8	b 1♯	16	*a* 3♯	0	C 0 ♭	45	g 6♭	37	*f* 4♭
	53	41	F 6"	49	e 7"	4	*b* 1"	12	D 2"	4	c 0"	49	*g* 6"
	52	29	G 4"	37	f 6"	45	*e* 7"	24	E 4"	16	d 2"	8	*c* 0"
	51	17	A 2"	25	g 4"	33	*f* 6"	36	F 5"	28	e 4"	20	*d* 2"
	50	5	B 0"	13	a 2"	21	*g* 4"	48	G 7"	40	f 5"	32	*e* 4"
Si, Seventh, 15 : 8.	**49**	46	E 6"	1	b 0"	9	*a* 2"	7	C 1"	52	g 7"	44	*f* 5"
	48	34	F 5"	42	e 6"	50	*d* 8"	19	D 3"	11	c 1"	3	*b* 0"
	47	22	G 3"	30	f 5"	38	*e* 6"	31	E 5"	23	d 3"	15	*c* 1"
	46	10	A 1"	18	g 3"	26	*f* 5"	43	F 6"	35	e 5"	27	*d* 3"
	45	51	D 7"	6	a 1"	14	*g* 3"	2	B 1"	47	f 6"	39	*e* 5"
43¾ Perfect Seventh.	**44**	39	E 5"	47	d 7"	2	*a* 1"	14	C 2"	6	b 1"	51	*f* 6"
	43	27	F 4"	35	e 5"	43	*d* 7"	26	D 4"	18	c 2"	10	*b* 1"
	42	15	G 2"	23	f 4"	31	*e* 5"	38	E 6"	30	d 4"	22	*c* 2"
	41	3	A 0"	11	g 2"	19	*f* 4"	50	F 7"	42	e 6"	34	*d* 4"
La, Sixth, 5 : 3.	**40**	44	D 6"	52	c 8"	7	*g* 2"	9	B 2"	1	a 0"	46	*e* 6"
	39	32	E 4"	40	d 6"	48	*c* 8"	21	C 3"	13	b 2"	5	*a* 0"
	38	20	F 3"	28	e 4"	36	*d* 6"	33	D 5"	25	c 3"	17	*b* 2"
	37	8	G 1"	16	f 3"	24	*e* 4"	45	E 7"	37	d 5"	29	*c* 3"
	36	49	C 7"	4	g 1"	12	*f* 3"	4	A 1"	49	e 7"	41	*d* 5♭
Dom. 3d, Minor.	**35**	37	D 5"	45	c 7"	0	*g* 1"	16	B 3"	8	a 1"	0	*g*♯
	34	25	E 3"	33	d 5"	41	*c* 7"	28	C 4"	20	b 3"	12	*a* 1♭
	33	13	F 2"	21	e 3"	29	*d* 5"	40	D 6"	32	c 4"	24	*b* 3"
Sol, Fifth, 3 : 2.	**32**	1	G 0"	9	f 2"	17	*e* 3"	52	B 8"	44	d 6"	36	*c* 4"
	31	42	C 6"	50	b 7"	5	*f* 2"	11	A 2"	3	g 0"	48	*d* 6"
	30	30	D 4"	38	c 6"	46	*b* 7"	23	B 4"	15	a 2"	7	*g* 0"
	29	18	E 2"	26	d 4"	34	*c* 6"	35	C 5"	27	b 4"	19	*a* 2"
	28	6	F 1"	14	e 2"	22	*d* 4"	47	D 7"	39	c 5"	31	*b* 4"
	27	47	B 6"	2	f 1"	10	*e* 2"	6	G 1"	51	d 7"	43	*c* 5♭
	26	35	C 5"	43	b 6"	51	*a* 8"	18	A 3"	10	g 1"	2	*f*♯
	25	23	D 3"	31	c 5"	39	*b* 6"	30	B 5"	22	a 3"	14	*g* 1♭
	24	11	E 1"	19	d 3"	27	*c* 5"	42	C 6"	34	b 5"	26	*a* 3"
Fa, Fourth, 4 : 3.	**23**	52	A 7"	7	e 1"	15	*d* 3"	1	F 0"	46	c 6"	38	*b* 5"
	22	40	B 5"	48	a 7"	3	*e* 1"	13	G 2"	5	f 0"	50	*c* 6"
	21	28	C 4"	36	b 5"	44	*a* 7"	25	A 4"	17	g 2"	9	*f* 0"
	20	16	D 2"	24	c 4"	32	*b* 5"	37	B 6"	29	a 4"	21	*g* 2"
	19	4	E 0"	12	d 2"	20	*c* 4"	49	C 7"	41	b 6"	33	*a* 4"
Mi, Third, 5 : 4.	**18**	45	A 6"	0	e 0"	8	*d* 2"	8	F 1"	0	e 0"	45	*b* 6"
	17	33	B 4"	41	a 6"	49	*g* 8"	20	G 3"	12	f 1"	4	*e* 0"
	16	21	C 3"	29	b 4"	37	*a* 6"	32	A 5"	24	g 3"	16	*f* 1"
	15	9	D 1"	17	c 3"	25	*b* 4"	44	B 7"	36	a 5"	28	*g* 3"
	14	50	G 7"	5	d 1"	13	*c* 3"	3	E 1"	48	b 7"	40	*a* 5"
	13	38	A 5"	46	g 7"	1	*d* 1"	15	F 2"	7	e 1"	52	*b* 7"
	12	26	B 3"	34	a 5"	42	*g* 7"	27	G 4"	19	f 2"	11	*e* 1"
	11	14	C 2"	22	b 3"	30	*a* 5"	39	A 6"	31	g 4"	23	*f* 2"
Re, Second, 9 : 8.	**10**	2	D 0"	10	c 2"	18	*b* 3"	51	B 8"	43	a 6"	35	*g* 4"
	9	43	G 6"	51	f 8"	6	*c* 2"	10	E 2"	2	d 0"	47	*a* 6"
7¾ Dom. 7th, minor.	**8**	31	A 4"	39	g 6"	47	*f* 8"	22	F 3"	14	e 2"	6	*d* 0"
	7	19	B 2"	27	a 4"	35	*g* 6"	34	G 5"	26	f 3"	18	*e* 2"
	6	7	C 1"	15	b 2"	23	*a* 4"	46	A 7"	38	g 5"	30	*f* 3"
	5	48	F 7"	3	e 1"	11	*b* 2"	5	D 1"	50	a 7"	42	*g* 5♭
	4	36	G 5"	44	f 7"	52	*e* 8"	17	E 3"	9	d 1"	1	*c*♯
	3	24	A 3"	32	g 5"	40	*f* 7"	29	F 4"	21	e 3"	13	*d* 1♭
	2	12	B 1"	20	a 3"	28	*g* 5"	41	G 6"	33	f 4"	25	*e* 3"
Do, Key-note.	**1**	0	C 0♯	8	b 1♯	16	*a* 3♯	0	C 0♭	45	g 6 ♭	37	*f* 4♭

their acuteness or increasing rapidity of vibration. The first half of the table assigned to "transposition by sharps" is divided into three double columns, of each of which the first column gives the number of sharps in the signature where the note at its right is found in the relation of key-note, third, etc., as indicated at the head of the column. The keys in flats have three double columns arranged in like manner. In each double column the figure following the letter shows how many times this letter is sharped or flatted. We read |14|C 2♯| "signature 14 sharps, key-note C×" (C twice sharped or double sharp). |30|D 4♯| is "signature 30 sharps, key-note D× ×" (quadruple sharp).

42. Each of the 53 notes is approximate to the six which appear in the same horizontal line, and these are the sounds which are made identical by the small correction mentioned. For example, if we divide the octave into 53 equal intervals, § 36, the first note of the table—which see—will serve as (1) C, key-note of the natural signature; (2) b♯, third in 8 sharps; (3) *a*×♯ (triple sharp), dominant third to the minor key in 16 sharps; (4) C, as before; (5) g^{bbbbbb} (sextuple flat), the third of 45 flats; (6) *f*^{bbbb}, dominant third in the minor of 37 flats.* And in like manner, the six notes of each line will have the same pitch.

43. Interesting relations are found in this table. Every signature has 12 sharps or flats more or less than that which precedes. And by the division into groups of 5 intervals, curious coincidences appear. At the bottom of the first column of key-notes is C: each five intervals advance the signature seven degrees, and at the notes 6, 11, 16, etc., we have C with 1, 2, 3 sharps regularly to 36, where C sextuple sharp is key-note of 49 sharps; and C has maintained its place in eight successive groups.† There are many mathematical harmonies which point to the conclusion that music should be given in its purity, and in accordance with the laws of numbers, on which all the pleasure derived from listening to it depends.

ADDITION TO § 30.—The perfect sevenths of the major key, **A**^{bb7} to **F**^{7}, answer for those of the minor key, **g**^{7} to **e**$^{\sharp 7}$; and the total of pipes in the octave will be 67.

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* Notes several times sharped or flatted always bear to each other the same relation as respects these signs. The thirds of C, F, and G have the same chromatic signs as their roots. Thus the third of C is e; of C♯, e♯; of C××, e××. But the thirds of D, E, A, and B have *one sharp more:* the third of D is f♯; of D××, f××♯. When these letters are flatted, the rule holds good, by changing "*one sharp more*" to "one flat less." The letters whose thirds take one sharp more—or one flat less—are B E A D (see p. 13, note). Those which do not are G C F.

† In examining the relative vibrations of the notes in a series of fifths descending in the octave below, taking C as 1, the following notes are represented by these decimals, all of which are recurring or perpetually repeated. F, $0{\cdot}\overline{666}$; Bb, $0{\cdot}\overline{888}$; Eb, $0.\overline{592}$; Ab, $0{\cdot}\overline{790123456}$; Db, $0{\cdot}\overline{526748971{,}193415637{,}860082904}$. The ratio of the comma below, or c, is $0{\cdot}987654320{,}\overline{987654320}$.

ART. II.—*A Sketch of the Geology of Southwestern Iowa;* by C. A. WHITE, M.D.

[In advance of his final report on the Geology of Iowa.]

WHATEVER may be the theories concerning the natural processes by which magnesian limestone has been formed, present indications strongly favor the opinion that with the close of the Subcarboniferous period its formation ceased among the rocks of Iowa. Very little limestone has been found among those rocks herein designated as the Lower Coal-measures, and the only analyses yet made of them are two, reported by Prof. Whitney, which yielded him less than one and a half per cent of the carbonate; but a considerable number of specimens of those here referred to the Upper Coal-measures have been examined by Prof. Hinrichs, the Chemist of the Survey, and in no case have they been found to contain so much as one per cent of magnesia —usually, only a trace.* A portion of these are perhaps stratigraphically equivalent with those in Missouri, which yielded Dr. Litton in one instance upward of twenty-six per cent of the carbonate.†

The dolomitization of the Devonian and Subcarboniferous rocks of Iowa is generally more complete in their northern extension, than farther to the southward. In the northern part of the state the Devonian rocks approach a true dolomite, but in the vicinities of Iowa City and Davenport, although still magnesian in part, some of the beds are tolerably pure limestone.

Parts of all the members of the Subcarboniferous series are more or less magnesian; the St. Louis limestone which forms the upper member of the series in this state, possessing that character in a marked degree in some of its beds, both in the northern and southern portions. The older rocks are so generally magnesian that no true limestone has been recognized in Iowa among those which occur between that of the lower Trenton period and the Devonian, along their outcrop; and the boring of the artesian well at Mt. Pleasant in Henry county (1125 feet deep) found the Niagara limestone and the so-called Hudson River shale possessing about the same characters as they do in the vicinity of Dubuque, two hundred miles to the northward.

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* Dr. Geinitz states upon the authority of Prof. Marcou that certain of the rocks exposed at Nebraska City are dolomitic limestone, but no analyses are referred to. (See Geinitz on the "Carbonformation und Dyas in Nebraska," Dresden, 1866.) Analyses of specimens *from the same beds* on the Iowa side of the Missouri river, only twelve miles distant, show only a faint trace of magnesia.

† In the Geological reports of Missouri, Dr. Litton gives the results of fourteen analyses of Coal-measure rock, without stating whether they are from the upper, middle or lower series. Four of the analyses show no magnesia; one, a trace; one 8·90, one 8·94, and one 26·53. The average of all, excluding the last, is about two and a half per cent of the carbonate.

These facts are mentioned in this connection, for the purpose of showing more clearly the lithological contrast between the Coal-measure rocks and those beneath them, in addition to the well known facts of their unconformability, and their natural paleontological differences.

Circumstances other than those suggested by geological features to be examined, rendered it desirable that the resumption of the state geological work should commence in the southwestern part, so that no opportunity has yet presented itself to make a complete examination of the full series of Lower Coal-measure strata, since this series does not appear at all in that part of the State, because the streams there have not eroded their valleys down to it through the upper series. This remark holds true of all that region composed of the counties of Decatur, Ringgold, Taylor, Page, Fremont, Mills, Pottawatamie, Montgomery, Cass, Adams, Adair, Union and Clarke. The greater part of last season's labors were expended in these, and other counties nearer the DesMoines river, and it is to this region almost exclusively that the following remarks upon the Upper Coal-measures are intended to apply. The Upper Coal-measure rocks are also known to be largely developed in the counties of Appanoose, Warren and Madison, and in these counties, along the Chariton, South, Middle and North rivers they are seen to rest on those of the lower series, the trend of the eastern border of the upper series passing through the last named and intervening counties, in a direction coinciding very nearly with the general course of the DesMoines river.

Although the Lower Coal-measures of Iowa have not been fully examined, yet a number of interesting facts have been collected concerning them by numerous visits to different localities. It has been satisfactorily ascertained that the lower series alone exists to the northward and eastward of the DesMoines river, the upper series lying to the southward and westward of it, but not extending so far as to its immediate vicinity. No definite knowledge of the entire thickness of the lower series has yet been obtained, but from data thus far collected it is not thought to average more than one hundred and fifty feet, but in some localities it is known to be much more, probably from local thickening of the strata.

Thus in Hardin county a section has been measured which reaches two hundred feet in thickness, and the presumption is strong that this does not represent the full series. The upper half of this section is a coarse ferruginous sandstone resting upon a four-foot bed of coal, all of which, with a part of the underlying fire-clay is seen exposed upon the bank of the Iowa river. The lower half is taken from a boring at the same locality which, according to the statement of the manager and the appearance of the material brought up, consists principally of bluish clayey shale. This boring was undertaken with the hope of finding a lower bed of coal, but was abandoned upon reaching the limestone. A remarkable fact in relation to this section, is the existence of the well defined border of the coal-field within two miles to the northeastward, where the Subcarboniferous limestone is seen well exposed. No satisfactory evidence of a disturbance of the strata could be discovered in the vicinity, and the bed of the Iowa river is the deepest point to which recent erosion has reached.

From these, and other similar facts collected along the border of the coal-field, it seems evident that the commencement of the Coal-measure epoch in Iowa found the then existing surface, whether of Subcarboniferous or Devonian rocks, very generally uneven by erosion; and not in consequence of any disturbance of the strata except the comparatively slight subsidence which caused the general unconformability before referred to. Instances of local accumulation of sandstone strata similar to that in Hardin county are not uncommon in the lower Coal-measures: those seen at Red Rock in Marion county, and below Ottumwa in Wapello county being of the same general character, and probably cotemporaneous deposits. These, and other irregular stratigraphical features in the series, will render its full elucidation a matter of some difficulty compared with similar labor in the upper series, which is composed to a large extent of limestones, and its horizons consequently more definite and extended. The lower series also, consisting as it does principally of friable sandstones and shales, presents comparatively few natural exposures of its strata, even where the drift material is not deep, and thus renders the topography of the region which it occupies readily distinguishable by the eye from that occupied by the upper series. It sems to be a well settled fact that nearly all the coal beds of the state belong to the lower series, the best beds being found in the lower part; and that this series alone can be properly designated as the productive Coal-measures of Iowa, since the upper series is now understood to contain but one bed of coal, the maximum thickness of which is only twenty inches.

Thus much by way of presenting the lithological contrast between the upper and lower Coal-measures as herein designated.

The most complete section found in all that region comprising the fifteen or sixteen counties before named, and perhaps the most complete one of the rocks of that age to be found in that state, was measured on the left valley-slope of Middle river, in the vicinity of Winterset, the county seat of Madison county. The strata of this section which are referred to the upper series, reach a thickness of one hundred and eighty feet, and are seen resting upon a bed of bluish, shaly, impure limestone which is referred to the lower series.

Twelve miles to the northward, the last named bed is recognized upon a branch of North river, with other beds below it, which are added to the former, and the whole designated as the Madison county section. It is numbered from the top downward.

Madison County Section.

	UPPER COAL-MEASURES.	
No. 1.	Thin bedded yellowish limestone, - - -	1 ft.
No. 2.	Light bluish marlite, - - - - -	4 "
No. 3.	Gray, massive limestone with dull fracture, - -	6 "
No. 4.	Gray, regularly bedded limestone with conchoidal fracture, - - - - - - -	12 "
No. 5.	Black, laminated, carbonaceous shale, - -	2 "
No. 6.	Gray limestone with marly partings like No. 4, -	34 "
No. 7.	Black shale like No. 5, - - - - -	2½ "
No. 8.	Regularly bedded gray limestone with many cherty layers, - - - - - - - -	15 "
No. 9.	Compact limestone with concretionary structure, -	2 "
No. 10.	Limestone of varying quality—in some parts siliceous and some of the interstitial material micaceous and finely arenaceous, - - - - -	16½ "
No. 11.	Impure coal, - - - - - - -	½ "
No. 12.	Light blue marlite, - - - - - -	2 "
No. 13.	Bluish, concretionary limestone, breaking readily into small fragments, - - - - -	5 "
No. 14.	Bluish and reddish clays, - - - - -	6 "
No. 15.	Sandy, micaceous shale, with fine grained micaceous sandstone in thin layers of bluish and greenish colors,	71 "
	LOWER COAL-MEASURES.	
No. 16.	Bluish, shaly, impure limestone, - - -	2 "
No. 17.	Bluish clayey shale, - - - - - -	13 "
No. 18.	Coal, - - - - - - - - -	2½ "
	Total,	197 ft.

It is considered probable that the members of the above section from No. 13 to No. 18 inclusive are equivalent to portions of the "Middle Coal-measures" of Prof. Swallow in Missouri, where the rocks of the whole epoch are more largely developed than in Iowa; but so far as these rocks of our own state have been investigated, they do not seem to warrant any other subdivisions than those here designated as the upper and lower series. The considerations, however, which have led to this subdivision are based principally upon lithological grounds, the result of observation in Iowa alone, and should future paleontological investigations suggest a change in this respect it will of course be made.

No fossils were found in Nos. 14 and 15, yet they are known to have a wide geographical range. No. 13 seems to be somewhat local in its extent, not having been recognized outside the limits of Madison county. It contains numerous fossils, all of which seem to be somewhat dwarfed in size, two or three of the species not having been found in any other bed. No lamellibranchiates were found in it, nor in any of the beds beneath it, yet it is not improbable that they exist in both. Its fossils seem to be confined principally to gasteropods and to the spiriferoid and terebratuloid brachiopods. In the extreme southwestern corner of the county several feet of sandstone were found resting upon this bed, which is not seen at all where the section was measured. Thus it seems that both this sandstone, and No. 13 thin out in certain directions, but no indications of a true unconformability have been observed. No. 11 is a carbonaceous band, also of limited extent, not having been recognized outside the limits of the county.

The beds occurring between No. 7 and No. 11, as well as their equivalents elsewhere, are much more fossiliferous than other portions of the section. A widely extended carbo-argillaceous horizon is comprised within the vertical limits of these few beds, embracing the only bed of coal of the upper series, and also a number of associated strata which have resulted from the deposition of material that once formed a congenial habitat for lamellibranchiates and gasteropods in addition to the prevailing species of brachiopods. The two former classes of mollusks are much less numerous in all the other strata, and in the more clearly calcareous beds wherever found, the lamellibranchiates are comparatively rare and appear to be confined to the Anatinidæ. The six or seven upper members, except the carbonaceous beds, are principally calcareous, and contain few other than the more common upper Coal-measure species, being largely confined to the brachiopods.

The county of Madison contains extensive and very fine exposures of the rocks of the preceding section, but so rapidly do the six or seven upper members disappear in all directions from its center that they have not been recognized outside of its limits, except perhaps to the southeastward a short distance. Therefore these beds may be regarded as the most recent of the paleozoic rocks now known in the state. The only probable exceptions to this, are the gypsum beds of Fort Dodge, the age of which is not yet known; and a coarse-grained, friable, ferruginous sandstone, to which I have given the provisional name of Nishnabotany sandstone. The latter is found at numerous points in the region of the East Nishnabotany river, sometimes reaching a thickness of more than thirty feet, and extends down to within thirty miles of the Missouri state line. It has not been fully investigated, but is known to lie unconformably upon the upper Coal-measure rocks of that region, and is suspected to be a part of the Dakota group of Cretaceous rocks, and therefore of Mesozoic age.

The disappearance of the upper members of the Madison county section is of course most rapid to the eastward and northward, because the drainage, as well as the borders of the formation are in those directions. They are all found exposed on Clanton's fork of Middle river, as far southward as the village of Peru, but the next exposure of rocks to the southward is on the Missouri river water-shed, and belongs to the carbo-argillaceous horizon before referred to; but its bed of coal does not appear so far eastward. This is the most northerly exposure of rocks on Grand river, and is ten miles from the one last mentioned, and five miles eastward from Afton, the county seat of Union county. Fossils are numerous here in the thin calcareous bands between the layers of carbonaceous and argillaceous shales; lamellibranchiates and gasteropods predominating. Although a hundred miles eastward from Nebraska City, it is unmistakably of the same horizon as division "C" of Prof. Marcou's section there (loc. cit.), as shown by the identity and association of fossils at both localities, as well as by their stratigraphical relations.* Following down Grand river the stream is found to have a fall amounting to a little more than the general dip of the strata, and consequently makes its exit from the state with its bed in the representative of No. 15 of the Madison county section. Immediately westward from Winterset the upper beds also disappear, but somewhat less rapidly. The first good exposure in that direction, after leaving Middle river at the west line of Madison county, is on the East Nishnabotany river, some forty miles distant; yet so simple is the geology of this region that no hesitation is felt in referring the strata there to about the horizon of Nos. 8, 9 and 10 of the preceding section, particularly since that view is corroborated by observations on intervening ground to the southward. The next important

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* Of the sixty-three species described and identified from division "C" of Prof. Marcou's section at Nebraska City by Dr. Geinitz, twenty-six are lamellibranchiates, and thirteen are gasteropods, which two classes of Mollusks contain the types which are principally relied upon by those gentlemen to prove the Permian age of the rocks at Nebraska City. I regret that I cannot fully agree with Dr. Geinitz in his identification of genera and species, yet I have been able to distinguish of those described and identified by him from that division, twenty species of those lamellibranchiates, and nearly half of those gasteropods, in the above named beds on Grand river; which beds are certainly not above the middle of the upper Coal-measure series as developed near the middle of the state. I moreover find that those lamellibranchiates and gasteropods with other species, characterize the horizon before referred to; the import of which is conceived to be that when they lived, they found there a congenial habitat, and not that the Permian period then and there commenced.

exposure in that direction is near Crescent City, a few miles above Council Bluffs, and is referred to about the horizon of No. 13 of the same section. Thus it will be seen that the line of strike is practically east and west between Madison county and the Missouri river.

It was remarked that the fall of Grand river is a little greater than the southerly dip of the strata over which it passes, so that one finds lower beds exposed as he goes down the stream. This would be expected from the fact that the stream bears a little to the eastward, obliquely across a slight westerly as well as southerly dip; but the fall of all those streams between that, and the Nishnabotany river, is almost exactly coincident with the dip of the strata, wherever they have cut their valleys through the heavy drift deposit. This is clearly seen along the Nodaway river, where the bed of coal of the horizon before referred to, reaches its greatest development, and is found a little above the water at intervals, from the northern part of Adams county, to a point a few miles within the state of Missouri. The impure limestones associated with the coal bed, along the course of this river and its branches contain, both above and below the coal, but more especially below it, very many species of fossils identical with those at the locality on Grand river just referred to, and also with those at Nebraska City, which Dr. Geinitz and Prof. Marcou refer to the Permian period. (loc. cit.)

No other rocks except those of this horizon appear along the Nodaway, but the Tarkeo has bared the equivalent of No. 15 of the previous section, in the northern part of Page county, as has also the East Nishnabotany, in Montgomery county. The lower part of the carbo-argillaceous horizon is occasionally seen in the valley slopes of those two streams, but its bed of coal is not seen west of the Nodaway, until the bluffs of the Missouri river are reached in the northwestern part of Fremont county, at the locality before mentioned, where the coal has diminished in thickness to six inches. The same bed of coal also diminishes in thickness as one goes down the Nodaway, being found only ten inches thick just within the state of Missouri; and to the eastward it thins out entirely before reaching Grand, or Middle river.

The following section was measured in Fremont county at the base of the bluffs, twelve miles northeastward from Nebraska City. It is numbered from the top downward and designated as the

Fremont County Section.

No. 1.	Thin bedded yellowish limestone, - - -	4½ ft.
No. 2.	Marly and carbonaceous shales, - - -	7 "
No. 3.	Impure coal, - - - - - - -	½ "
No. 4.	Light bluish fire clay with fossil grasses? - -	2 "

No. 5.	Compact bluish limestone with shaly partings, -	4	ft.
No. 6.	Yellowish and bluish marlites, - - - -	6	"
No. 7.	Gray limestone with small concretions, - -	4	"
No. 8.	Unexposed, - - - - - - - -	6	"
No. 9.	Compact gray limestone, - - - - -	1½	"
No. 10.	Light yellow indurated marl, - - - -	4	"
No. 11.	Yellowish siliceous limestone with flinty masses, -	2½	"
No. 12.	Yellowish earthy shale with concretionary layers of limestone, - - - - - - - -	3	"
No. 13.	Compact, gray limestone, - - - -	1	"
No. 14.	Yellowish earthy shale, - - - - -	2	"
No. 15.	Heavy bedded limestone, with dull fracture, -	3	"
No. 16.	Bluish shale, - - - - - - -	½	"
No. 17.	Soft, yellowish siliceous stone, crowded with Fusulina,	1½	"
No. 18.	Massive, light gray limestone with dull fracture,	16	"
No. 19.	Bluish marlite with 9 inch band of limestone, -	4½	"
No. 20.	Compact bluish limestone with small concretions,	2	"
No. 21.	Bluish marlite, - - - - - -	4	"
No. 22.	Bluish, thin-bedded, fine-grained, micaceous sandstone,	1½	"
	Total,	81	"

The localities of the two sections here given are nearly one hundred miles apart, yet their equivalencies are very satisfactorily determined. No. 22 of the Fremont county section is regarded as equivalent with No. 15 of the preceding one; and the remainder of the Fremont county section, as equivalent with that portion of the preceding one between the lower portion of No. 6, and the top of No. 15. No. 7 of the Madison county section is regarded as equivalent with Nos. 2 and 3 of that of Fremont county, both belonging to the carbo-argillaceous horizon before described. Beneath this horizon, and more or less associated with it, there is quite a definite Fusulina horizon, which forms a conspicuous stratigraphical feature in the southwestern counties, but since these fossils range through the entire upper series they cannot always be relied upon for stratigraphical determinations. It is quite otherwise, however, with the horizon first named, for we are able to recognize this, with more or less certainty all over the region in question, both by its bed of coal, or carbonaceous character where that does not exist, and also by its peculiar paleontological features.

The subject may be briefly summed up thus:

1. Besides the usual paleontological and lithological differences between the Coal-measure rocks and those beneath them, there seems to be in Iowa almost an entire absence of magnesia in the former rocks, while it prevails so largely in those of older date.

2. The lower Coal-measures contain nearly all the coal of the state, and are composed principally of sandstones and shales.

3. The lower Coal-measures alone are found along the DesMoines river, and to the northward and eastward of it.

4. The upper Coal-measures lie wholly to the southward and westward of that river, the receding borders of that formation resting conformably upon the lower series. Consequently the rocks of the upper series do not reach the border of the Coal-field, nor do they ever lap upon the rocks of older date than the lower Coal-measures, as they are supposed to do in Illinois.

5. The region more particularly described in this article is comprised within that portion of the three southern tiers of counties lying between the Missouri river, and a line running southward from the city of DesMoines.

6. The rocks of this region belong principally to the upper Coal-measures, which are seen resting upon the lower Coal-measures at the eastern border.

7. A few beds of the upper series thin out, but no true unconformability is recognized.

8. The upper series is believed to contain but one bed of coal, properly speaking, the maximum thickness of which is twenty inches, and its greatest development along the Nodaway river.

9. The stratigraphy of the whole region is very simple, the line of strike being practically east and west, and the dip, to the southward nearly coincident with the fall of the streams.

10. The highest Paleozoic beds are to be found in Madison county and belong to the upper Coal-measures.

11. The lowest beds exposed along the Missouri river, or upon its water-shed within the region herein described, belong also to the upper Coal-measures as designated on the previous pages.

12. No Subcarboniferous rocks are found westward from the immediate vicinity of the DesMoines river.

13. There is a definite carbo-argillaceous horizon recognized over the greater part of this region which is characterized by the bed of coal before referred to, and in the strata of which lamellibranchiates and gasteropods prevail, and sometimes predominate.

14. Above this horizon as well as below it, characteristic upper Coal-measure brachiopods, and other fossils prevail.

15. Below this horizon the rocks increase in thickness and calcareous character from east to west, and probably also to the southward.

16. Nishnabotany sandstone occurs in the counties of Mills, Montgomery, Cass and Pottowatamie. It lies unconformably upon the upper Coal-measure rocks, and is supposed to be of Cretaceous age.

Iowa City, Iowa, March 27th, 1867.

ART. III.—*Notes on the Geology of Kansas;*[*] by F. V. HAYDEN.

PERHAPS few portions of the globe of the same size have furnished more facts and collections of interest to scientific men, both in Geology and Paleontology, than those drained by the Missouri river and its tributaries. Since 1853 the greater part of my time has been devoted to the development of the geology and natural history of this great region. During that period I have personally examined the greater part of the territories of Kansas, of Nebraska, Dakota, Montana, Idaho and Colorado, and it is but natural that I should read with great care and interest a publication on the geology of any portion of that country emanating from any other source. It was on this account that an official report on the Geology of Kansas by Prof. Swallow was hailed with pleasure. In the summer of 1858 Mr. Meek and the writer made a careful examination of a large portion of Kansas from Leavenworth City westward to Smoky Hill, and the results of that exploration were published in the Proceedings of the Academy of Natural Sciences at Philadelphia, Jan. 1859. In that paper opinions were advanced in regard to the relations of the Permian to the Carboniferous rocks which were accepted by most of the geologists in this country and in Europe. In the report of Prof. Swallow, however, opinions have been expressed on some points opposite to those in the paper above referred to, and it is the object of this article to pass these opinions under review. Mr. Meek has furnished some carefully prepared notes which form the substance of this article.

Although Prof. Swallow acknowledges (p. 43) that these Permian strata (his Lower Permian) graduate into, and are so nearly conformable to, the Coal-measures below, that "no want of conformability can be detected by examining any one locality, though the line of junction be traced a long distance;" "Yet," he continues, "when sections are made across the line of junction at distant points, it becomes evident that there is a striking non-conformability. When the sections made across this line on the Kansas, at Manhattan and above, are compared with those on the Blue, though separated by several miles, there is no difficulty in identifying all the important strata in one with those of the others; and when these sections are compared with those at Mill Creek, some 25 miles east, and with those on the Cottonwood, 60 miles south from Manhattan, the prominent beds are easily identified down to the lowest of the Permian, No. 84 of the above section; but Nos. 85–95 from the section near Manhattan are not found, when No. 84 rests directly down

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[*] Preliminary Report of the Geological Survey of Kansas. By G. C. SWALLOW, State Geologist. Printed at Lawrence, Kansas, 1866.

upon the *Fusulina* shales." Now the facts here mentioned, even if we admit that the very same beds have not been mistaken for others, or the contrary, from a change in their lithological characters at different localities, do not establish non-conformability as that term is used by geologists. As properly used in geology, the word unconformable is applied to two or more beds or sets of strata, resting one upon another, and dipping at different angles or in different directions in consequence of the older beds being tilted from their horizontal condition previously to the deposition of the later ones. Such disturbances or want of conformity in the planes of strata, are usually accompanied by differences in the groups of fossils above and below the line of non-conformity, and thus indicate a considerable change of physical conditions, as well as the lapses of long periods of time, between the deposition of the discordant strata; and hence are usually admitted as marking the close of one period and the introduction of another. The mere thinning out in some given direction of particular beds and thickening of others, however, may occur in any part of the same formation without indicating any such disturbances, lapse of time, or changes of physical conditions between the deposition of the beds above and below the horizon of the locally absent strata. Every one who has studied our western Coal-measures attentively, must be aware that nothing is more common than the thinning out of particular beds of considerable thickness, sometimes even between no very distantly separated localities. Lesquereux has shown this to be the case at various horizons in the Coal-measures of Kentucky, Illinois and other western States, as well as Pennsylvania. For instance, in speaking of Coals No. 1B, and 1C (Ill. Report, i, p. 216), he says they are usually separated by 55 feet of strata, but "from the absence of the strata separating these beds of coal, they sometimes come in contact, forming a single bank." Again, on page 218 of the same report in speaking of the divisions of bed B often found separated by a thin parting of clay, he mentions an instance of this parting, which is sometimes entirely wanting, swelling out from a mere seam so as to form a bed of shale 10 feet in thickness, in a distance of only 300 yards. Again (ib., p. 228), in speaking of the Colchester bed (Coal No. 3) generally separated from the conglomerate, or mill-stone grit, by from 170 to 200 feet of strata, including coals, 1B, 1C and 2, he says that, "by an apparently abnormal deposition of the Coal-measures, which I have tried to explain elsewhere, the Colchester coal almost immediately overlies the conglomerate formation," thus showing from 170 to 200 feet of intervening strata to be wanting here.

In the same Report, he has shown, that in tracing the Coal-measures a little west of north from southeastern Illinois where this whole series is well developed, and has been clearly identified by him from its fossil plants with the Coal-measures of Europe as well as with the various members of the same formation in Indiana, Kentucky, Ohio and Pennsylvania, it is found that almost the whole of the series below the horizon of the "Anvil rock" six or seven hundred feet in thickness of the Kentucky section, has thinned out and disappeared at the northern margin of the Illinois Coal-field, so as to leave the Upper Coal-measures, and some portions of the Lower resting directly down upon Silurian rocks. Facts like the latter are evidently to be accounted for, either by supposing the northern part of the state to have been more elevated than the southern at the commencement of the coal epoch, and that as the whole area became gradually more and more depressed, the marshes, or whatever conditions gave origin to the coal, extended farther and farther northward with the formation of each successive bed; or that the southern districts sank more rapidly than the northern, and consequently received several successive beds that did not extend far northward in consequence of the greater elevation of that region at this period of their deposition. More local instances, however, like those mentioned by Prof. Swallow, of the thinning out of particular beds are evidently to be accounted for by the erosion of one or several beds in places, before the deposition of others upon them. Prof. Lesley mentions an instance of this kind in the Lower Coal-measures of Cannelton, Ia. (see Owen's Indiana Report, p. 345), where a bed of shale 46 feet in thickness thins out and entirely disappears in a distance of two miles, so as to bring directly down, upon a bed of coal, a stratum of sandstone, separated from it at another locality so near by the whole thickness of shale just mentioned. These local erosions of one or more beds previous to the deposition of others have occurred in various formations, but more particularly in the Coal-measures. On this subject Lesquereux says (note, p. 211, Ill. Report, i), "local erosions at any part of the thickness of the Coal-measures are of frequent occurrence." When we consider the conditions under which the Coal-measures were probably formed, the wonder is that such facts are not more common than the contrary. Hence we should be very cautious in viewing them as evidences of a break in the series, such as marks the close of one condition of things, and the introduction of a new epoch.

But we will now turn to the groups of fossils found in these so-called Lower Permian rocks, and see how far they sustain the opinion that there was a physical break of the importance claimed, separating them from the Upper Coal-measures. As Prof. Swallow, with few exceptions, mentions in the Report under review only by their generic or class names the fossils found in the rocks under consideration, we have to refer to his papers published in the Transactions of the St. Louis Academy of Sciences in 1858, and in the Am. Jour. Sci., vol. xxvi, p. 182, of the same year, for his views in regard to their specific relations. In these papers he shows by a tabular arrangement the range in the various rocks of each species mentioned, as he understood them. In these lists he enumerates about 70 species of Upper Coal-measure and Permian fossils, 16 of which he shows to be common to the Upper Coal-measures and his Lower Permian, and two to the latter and the Upper Permian.

The following well known, and, with one or two exceptions, widely distributed species of our western Coal-measures, are those given by him as common to the Lower Permian and Upper Coal-measures, viz: *Productus semireticulatus*, *P. Rogersi*, *P. aequicostatus*, *Spirifer cameratus*, *S. planoconvexus*, *S. pectinifera? Chonetes Flemingii*, *Orthisina umbraculum*,* *O. Missouriensis*, *Rhynchonella Osagensis*, *Terebratula? subtilita*, *Myalina recta*, *M. subquadrata*, *M. Kansasensis*, *Allorisma Minnehaha*, and *Natica Pricei;* he also identifies with this *Macrocheilus spiratus* McCoy, a Subcarboniferous species. With the exception of *Spirifer pectinifera* Sowerby, with which we are not acquainted, and *Macrocheilus spiratus*, we know all of these common Coal-measure species occur abundantly in the so-called Lower Permian of Kansas; also the following other Coal-measure species, viz., *Aviculo-pecten occidentalis* (*Pecten Cleavlandicus* of Prof. Swallow's list), *Nautilus occidentalis* Swallow (afterward described from the Coal-measures of Illinois by McChesney under another name), *Fusulina cylindrica* in great numbers (or the Coal-measure forms generally referred to that species in the west), *Chonetes mucronata*, *Productus Calhounianus*, *Euomphalus rugosus* Hall (not Sowerby), a small *Spirifer* often referred to *S. lineatus*, *Phillipsia Cliftonensis* Shumard, and others. From the same so-called Lower Permian Prof. Swallow also positively identifies 10 European Permian species, and some 5 or 6 others with doubt; also with doubt, 1 Subcarboniferous species, 3 Triassic, and 1 Liassic European forms.

We may, however, well question the accuracy of these determinations, by which Carboniferous, Permian, Triassic and Liassic species are made to occur together in the same beds, especially in beds known to contain so many of our commonest Coal-measure species, and four genera, i. e., *Petalodus*, *Phillipsia*, *Bellerophon* and *Fusulina* not known in the Permian of Europe. Prof. Swallow says in regard to this so-called lower Permian, that the appearance at this point of numerous new fossils, many of which are well known Permian types, of the genera *Monotis*, *Bakevellia*, *Schizodus*, *Pleurophorus*, *Synocladia* and *Tham-*

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* We use the names as given in the list. *Orthisina* as now restricted is a Silurian genus, and the *Natica* is a *Naticopsis.*

niscus, clearly indicates the introduction of the Permian age. The genus *Monotis*, however (as the name is here applied), also occurs far below the horizon where he would make the line of separation,—hundreds of feet, indeed down in what he includes in the Coal-measures, even near the level of the Missouri at Leavenworth, Kansas; it is also now known to occur in Illinois at a point near the horizon of the eleventh Coal-bed, above which the Coal-measures are well marked. All the other genera mentioned, and most of the very same species likewise occur in the admitted Upper Coal-measures of Kansas and the adjoining states, while *Pleurophorus* and *Schizodus* occur in the Subcarboniferous rocks of Illinois. Indeed there is now known a species of *Pleurophorus* from the Keokuk Limestone, of the Mountain Limestone series, at Warsaw, Illinois, as nearly like the European Permian, *P. costatus*, as any known form in Kansas rocks.

From all these facts, we think the evidence, both paleontological and stratigraphical, bears directly against the idea of there being a proper break in the series at the horizon mentioned by Prof. Swallow, much less "a striking non-conformity." The very fact that the missing strata, the absence of which on Mill creek is regarded as proving a break, do occur in their proper place on Kansas and Blue rivers, only 25 miles distant, shows clearly that this is one of those cases of the erosion of particular beds at certain localities, previous to the deposition of others, so common in the Coal-measures, and not one of the great general disturbances of the order of things, such as produced non-conformity of the beds, and usually accompanied the introduction of a new fauna. Nor should any great weight be given to the general lighter color of the beds above the supposed break; for every one knows how little reliance can be placed on mere color and other lithological characters in distinguishing formations.* In addition to this, the change of color is not abrupt, while lighter and darker beds continue to alternate above the supposed break, and to a less extent below it.

All the evidence sustains the opinion expressed by Meek and Hayden in 1859 (Proc. Acad. Nat. Sci., Jan. 1859), that there is in Kansas an unbroken series from the Coal-measures to the top of the Permian of this region; and that no one studying these rocks and their fossils, without any previous knowledge of the classifi-

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* It may be of some interest to state here, that the matrix containing some fossils recently sent to the Smithsonian Institution by Mr. E. G. Squier, from an island in Lake Titicaca, South America, 14,500 feet above the sea, and now being studied by Mr. Meek, could not be distinguished, lithologically, from some of the Permian strata of Kansas, and the Black Hills in Nebraska. And yet these rocks in the high Andes have been referred by D'Orbigny and other eminent European authorities to the Mountain limestone. The fossils, however, from Lake Titicaca, agree in several instances with those of our western Coal-measures.

cations adopted in the old world, would have separated the Permian at all from the Coal-measures, as distinct groups. Starting far down in the Coal-measures below the supposed line of separation, we have, along with great numbers of all our common Coal-measure forms, an occasional *Monotis* (so-called), *Bakevellia*, *Pleurophorus*, *Myalina*, &c., that might apparently, in some instances, be even identified specifically with European Permian species. As we ascend in the series, we find that, after going some distance above the supposed line of demarkation, the Carboniferous species gradually begin to disappear, and the Permian types become rather more common, in particular beds, until we have ascended to a point near the horizon Prof. Swallow makes the line between the Upper and Lower Permian, when we find we have almost completely lost sight of the familiar Carboniferous species, a few of which had continued on up to near this point, and see scarcely any but forms such as in Europe would be regarded as Permian types. There is no physical break here, however, nor *abrupt* change of fossils. Hence Meek and Hayden regarded the beds below the horizon down so far as to include most, if not nearly all, of Prof. Swallow's Lower Permian, as an intermediate connecting series between the Permian and Coal-measures which, if worthy of a distinct name at all from the latter, should be called Permo-carboniferous, while the beds above, they regarded alone as properly the equivalent of the true Permian of Europe.

The occurrence of a few types that would generally be regarded as Permian, along with numerous well-known Coal-measure species, far below the true Permian, only accords with facts observed in other formations in this country, where certain types evidently made their appearance here long before they are known to have appeared in Europe. In this connection we need but refer to the Cretaceous plants of Nebraska, most of which belong to genera, and some of them to species, scarcely distinguishable from forms known in Europe in rocks not older than the later Tertiary. Even one of the best botanical paleontologists of Europe thought some of them probably identical with Miocene species, and yet they hold a position near 800 feet below beds containing numerous species of *Ammonites*, *Baculites*, *Scaphites*, *Inoceramus*, and various other unquestionably Cretaceous types. Similar facts have also been brought out by the California Survey. It is also worthy of note that in several cases these few Permian types occurring far down in the Coal-measures in Kansas appear in particular layers, similar to the Permian rocks in composition, and alternating with other beds containing only Carboniferous fossils, much like Barrande's "Colonies" in the Silurian rocks of Bohemia.

In regard to the Permian discovery in Kansas, we regret to see that Prof. Swallow (doubtless inadvertently) here in an official report, uses language, which when taken in connection with the fact that he nowhere alludes to the labors of others in that region would lead some to think he had intentionally ignored the agency of any other parties in that discovery and was claiming it as wholly his own. Thus in a note at the bottom of page 42, after speaking of the discovery of Permian rocks in Kansas, he says "this discovery was first announced by myself Feb. 22, 1858. See Trans. Acad. Sci. St. Louis, vol. i."

We had supposed the dispute in regard to this discovery was long since amicably settled, when Prof. Swallow published in this Journal, [2], vol. xxvi, page 188, in a paper on the Kansas Permian, the statement that "it is but just to state in this connection, that, so far as I know, Mr. Meek first discovered the Permian character of the Kansas fossils, and communicated to Maj. Hawn his impression on this subject on the 3d of Sept., 1857. He also mentioned his discovery, as I am informed, to some friends at the Smithsonian Institution on the 17th of January, 1858, and communicated the same to Prof. Leidy, on the 16th of March.* Maj. Hawn frankly declares that his first impressions that the rocks in question might be Permian are due to Mr. Meek." We may be mistaken; but the literal wording of Prof. Swallow's note quoted above, in connection with his silence in regard to the agency of others in this discovery, might be understood, without some explanation, as indicating an intention to claim it on the strength of the fact that his announcement, communicating the discovery to a regularly established scientific institution at an earlier date than the reading of Meek and Hayden's paper before the Albany Institute, gave him a right to claim it as entirely his own. On this ground, however, Meek and Hayden would still be in advance, for they had not only made it known verbally to friends in Washington, about the 17th of Jan., 1858, but actually had a record made of it at the Smithsonian Institution, (as all know, established for the increase and diffusion of knowledge) on the 19th of Jan., 1858. This record or memorandum, which we are permitted to give here, was written by Prof. Baird and reads as follows:—

"1858, Jan. 19th, Mr. Meek and Dr. Hayden showed me a series of fossils arranged on the table of room 110, from Dr. Hayden's collections under Lieut. Warren in 1857, which they stated

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* This latter date is doubtless a misprint for 16th of Jan., for the discovery was actually published on the 4th of March, 1858, by Meek and Hayden in a paper read before the Albany Institute on the 2d of March, 1858, extras of which were distributed by them two days after, and before the issue of Prof. Swallow's paper alluded to above: though Prof. Swallow had a short time previously published a note on the subject in a St. Louis newspaper. He also published another notice in this Journal, issued, if we mistake not, between 4th and 10th of March, 1858.

to represent in succession, first, Potsdam Sandstone from the Black Hills; 2d, forms indicating Permian both in Kansas and the region of the Black Hills; 3d, fossils of the Jurassic type from the region of the Black Hills; 4th, Carboniferous from the Black Hills. (Signed) S. F. BAIRD."

This memorandum is not noted in the order the fossils were arranged; the clause in regard to the Carboniferous was accidentally omitted between the Potsdam Sandstone and the Permian, and then added at the end after the Jurassic. Nor is any mention made of the fossils sent from Kansas to Mr. Meek by Mr. Hawn, nor of a small collection from the same region communicated by Dr. Cooper which were at the same time lying on the table; though both of these gentlemen received full credit for collecting and sending these fossils, in the paper published by Meek and Hayden.

It is with considerable reluctance that this subject, which we had thought entirely settled, has been touched upon here; but the facts already mentioned seemed to demand such a statement. At the same time that Meek and Hayden manifest no desire to ignore the connection of Mr. Hawn and Prof. Swallow with the Permian discovery, they have the right to expect their own agency in the matter to be acknowledged, especially in an official report on the geology of that region, treating upon this formation and speaking of the labors of others in that connection.*

In Prof. Swallow's former papers, he gives the total thickness of the Upper and Lower Permian as he understands them, at 820 feet, and in the report under review the thickness of the same beds is given as 704 feet 1 inch. This is quite as near an

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* We have made some remarks in regard to the Permian discovery in this article, not with the idea of convincing any one at all familiar with the facts of the case, for several of the ablest geologists of the present time have indicated directly or indirectly their opinion on this matter, but because our silence might be taken as entire submission to the apparent disposition on the part of some geologists to ignore our agency in the development of the geology of the West. No true-minded geologist in reading Prof. Swallow's statements under his own signature as given in this article and the note by Mr. Meek appended to a paper published in the Trans. Albany Institute, March 2d, 1858, can possibly err in regard to the *real* discoverer of the Permian in Kansas. During the year 1857, I had the good fortune to be connected as geologist, with a U. S. exploring expedition to the Black Hills under the command of Gen. G. K. Warren, U. S. A. Among some fossils I had collected at various points in the Black Hills and along the Missouri river, were forms much like those of the Permian of Europe. Maj. Hawn and Dr. Cooper had also sent to Mr. Meek collections from Kansas. In numerous letters from Mr. Meek while I was in the West he continually impressed upon me the importance of looking out for Permian fossils. In a letter dated Oct. 20th, 1857, he said he had received "some fossils sent on by Maj. Hawn evidently either Upper Coal-measure forms or *Permian*. I would not be astonished if they should prove to be the latter." Again, Nov. 10th, 1857, speaking of some fossils I had sent him from near Nebraska City, "among them I think I recognized a ***Monotis*** [***Pseudomonotis***], a genus not known in the old world in older rocks than the *Permian*." F. V. H.

agreement as could be expected in the measurement of such variable strata at different localities; yet when there is a difference of 116 feet, and the numerous subordinate beds composing the whole are stated as varying in thickness at different places from 1 to 15 feet, 4 to 12 feet, 10 to 25 feet, and so on, one would naturally suppose that the odd inch might have been dispensed with in summing up the whole, as it gives the appearance of minute exactness, manifestly unattainable in the measurement of such strata.

In regard to the beds referred with a ? by Prof. Swallow and Mr. Hawn to the Trias in Kansas, we can only say that they may be Trias, Permian or even Jurassic, so far as any evidence yet obtained goes. With those gentlemen we are much inclined to believe they will be found to belong to the Trias. They are known to hold a position immediately above Permian beds and beneath the Cretaceous, while they are very similar to portions of the Trias of Europe in their lithological characters. At the same time, it is by no means demonstrated that they may not prove to belong to the Permian. Prof. Swallow, at first, referred to this horizon a trilobate exogenous leaf, a small bivalve he thought doubtfully identical with *Nucula speciosa* Münster, from the Muschelkalk (not a true *Nucula* by the way), and another shell he thought identical with *Myophoria orbicularis* Goldf. (sp.) As Prof. Swallow now only alludes to the supposed *Nucula*, and makes no mention of the *Myophoria* in his report, in speaking of this rock, it is probable he has found the latter to be a *Schizodus* or some other type from the Permian; and as the trilobate leaf is now known to be from the Cretaceous, as shown by Meek and Hayden, the paleontological evidence yet obtained of the Triassic age of these beds seems to be narrowing down to a single little bivalve, of doubtful genus. It is true Prof. Mudge thinks he has found bird tracks in a sandstone of this horizon, but as he also speaks of finding exogenous leaves in the same position, it seems probable that the tracks mentioned by him are from the sandstone belonging to the Cretaceous, in which so many leaves have been found in that region. We must therefore await further evidence before we can regard the existence of the Trias in eastern Kansas as demonstrated.

ART. IV.—*On the systematic value of Rhynchophorous Coleoptera:* —an Abstract of a Memoir read before the National Academy of Sciences, at Washington, Jan. 24th, 1867; by JOHN L. LECONTE, M.D.

IN the empirical arrangement of the families of Coleoptera, which has resulted from the adoption of the tarsal system of division, the families contained in the great natural group of Heteromera are followed by the Curculionidæ and Scolytidæ, which, more or less subdivided into smaller families, have been supposed to establish a linear relation between the rostrated Heteromera (Salpingus, Rhinosimus, &c.) to the Cerambycidæ and Chrysomelidæ, the great types of the Pseudotetramera, or Subpentamera, of various authors.

It is the object of the present investigation to determine the limits, and the relations of the first mentioned of these types, the Rhynchophora.

The inferiority of this type is manifested, not only in the larval condition by the limited number or absence of visual lenses, the want of locomotive appendages, the feeble development or entire want of antennæ, and the unchitinized epidermis; but also by the combination in the imago of characters belonging to a perfectly developed organism with others pertaining to an inferior grade in the scale of Coleoptera.

Thus, for instance, while we perceive in the other series of beetles, that the lower forms retain certain larval characters, as evidenced by the extension of the coxæ, the imperfection of the anterior coxal cavities, the softness of the integuments, and the want of centralization in the abdomen, all such degradational characters are absent in the Rhynchophora.

Other characters representing low grades in their respective series do not appear in the Rhynchophora, such as vegetative growth of the organs of sense, indicated by pectinate or flabellate antennæ, or excessive length of palpi.

On the contrary, we find in the Rhynchophora, that the integuments are perfectly chitinized: the elytra never abbreviated or wanting; the anterior coxæ are always completely enclosed; the ventral segments, usually five, never exceed six in number.

The plan of degradation, in passing from the higher to the lower forms, is by the extension of the longitudinal axis of the body, in its anterior half; this is usually most strongly manifested in the head, and exhibited not only by the length of the beak, but by the conformation of the lower floor of the mouth.

Commencing with those Curculionidæ (Adelognathi *Lacordaire*,) in which the mentum fills the gular emargination, as in the higher Tenebrionidæ, we find a gradual lessening in size of the mentum, itself becoming supported upon a broad, short, gular peduncle, permitting the maxillæ to become visible, (Phanerognathi, Cohort 1, *Lacordaire*): next the gular peduncle becomes elongated, and bilobed, receiving the mentum, now reduced to very small size, between its lobes (Phanerognathi, Cohort 11, and also Brenthidæ, and Anthribidæ).

Having in the continuance of my work on the Classification of Coleoptera of North America, recently commenced a critical study of our Rhynchophora, I became aware of the impossibility of intercalating them between the Heteromera and Subpentamera, and am now convinced that they represent a special type, which must be isolated from all other types of Coleoptera, possessing a systematic value equal to all the others combined.

In seeking for the characters which should define this type, I observed a remarkable difference in the arrangement of the pieces of the under surface of the prothorax, heretofore overlooked, and so far as I know, confined to this particular type.

In other Coleoptera, the prosternum is either extended behind the anterior coxæ, so as to form part of the hind margin of the segment, thus coming in contact with the mesosternum, or it is cut off between the coxæ, and in this case (as in many others) the coxal cavities are open behind: in the few exceptions (Derodontus, Dacoderus) in which the coxæ are contiguous and the cavities closed behind, the prosternum still extends behind the coxæ, to the hind margin of the segment, as is shown by the short sutures separating the epimera from the medial piece of the prosternum.

I have represented these modifications of form in the adjoining wood-cuts. Fig. 1, under surface of prothorax of a Carabide (Pasimachus); the coxal cavities are closed, and the epimera and episterna well defined. Fig. 2, do. of a Scarabæide (Lachnoster-

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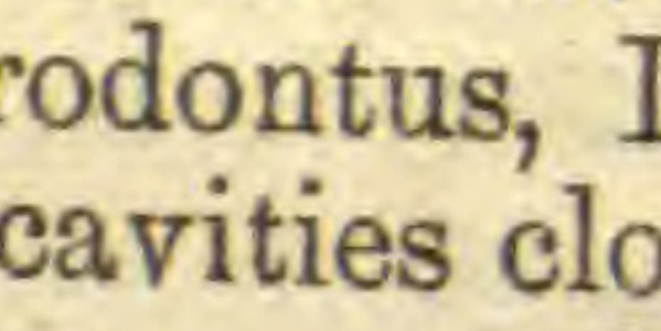

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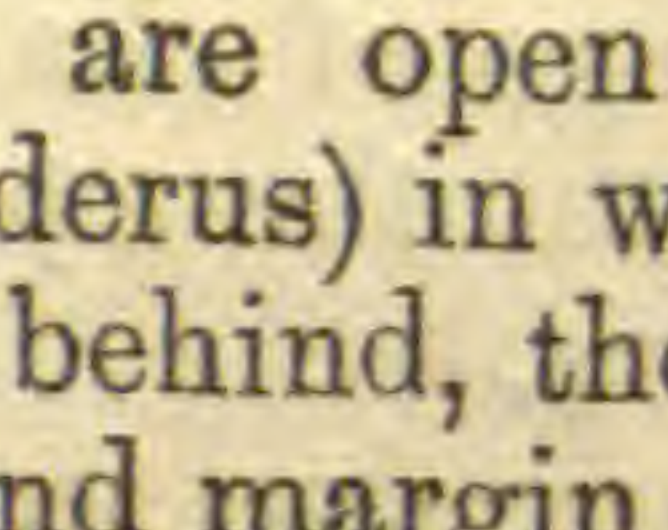

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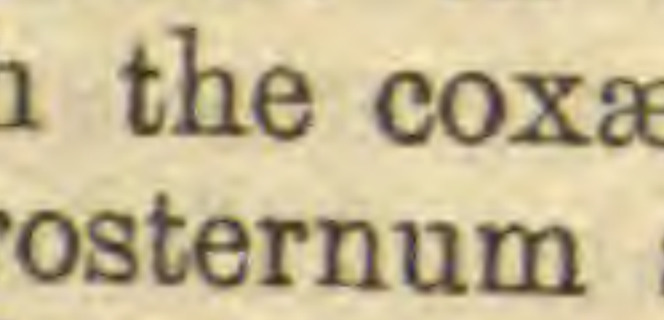

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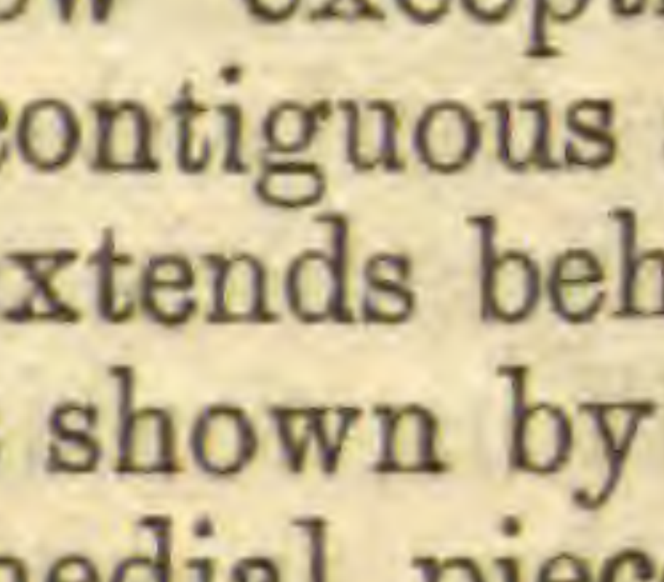

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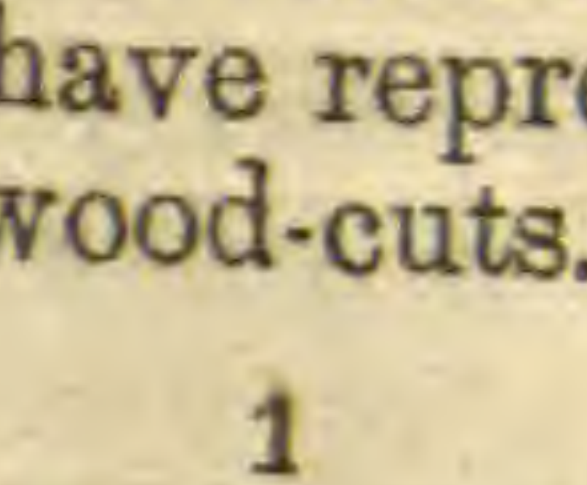

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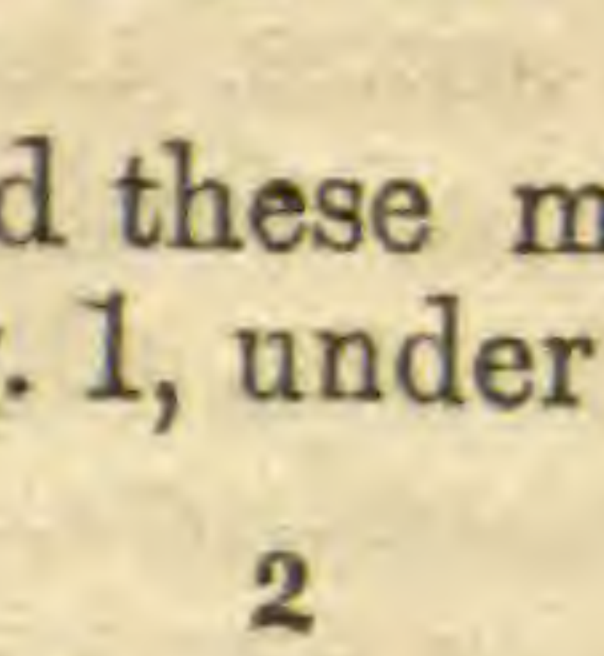

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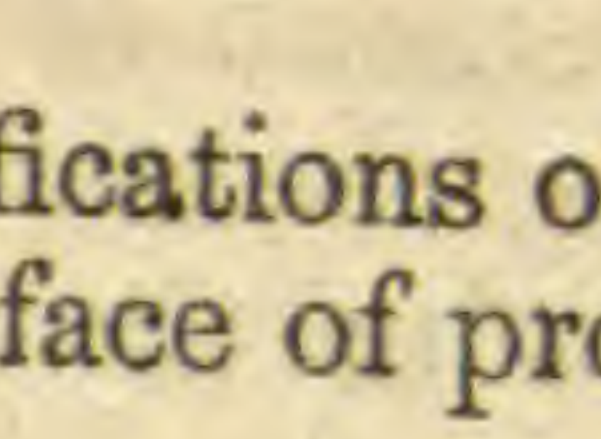

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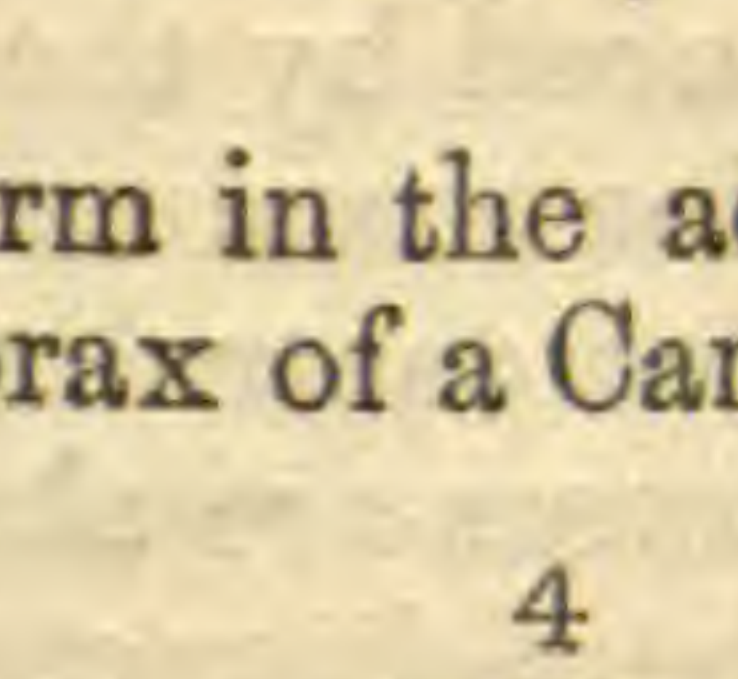

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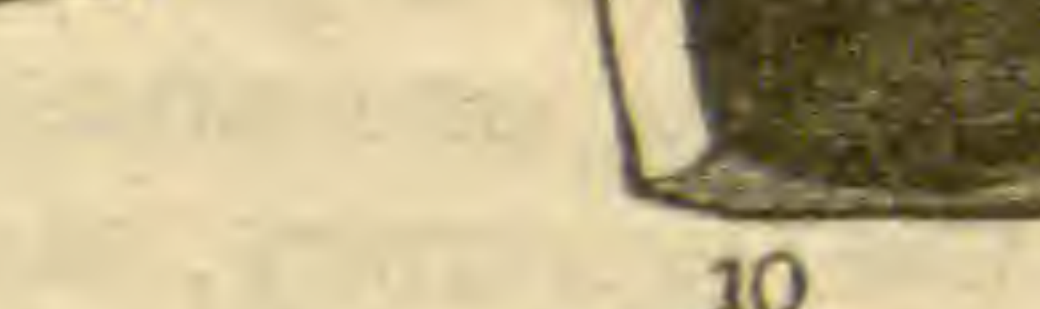

na): the coxæ are transverse, the cavities closed, the side pieces not distinct. Fig. 3, do. of Cucujus; coxal cavities open behind, side pieces not distinct. Fig. 4, do. of Telephorus: coxal cavities confluent and open behind.

In Rhynchophora the prothoracic sutures are obliterated, there is no separation between the prosternum and episterna, and very rarely between the latter and the pronotum: the coxal cavities, frequently confluent, are always closed behind, *by the epimera*, which become connate on the median line, enclosing the hind part of the prosternum, thus cutting it off completely from the mesothoracic segment.

Fig. 5 represents this arrangement of parts in a Brenthide, in which family the extreme limit of degradation by linear extension is reached. Fig. 6, under surface of prothorax of a Calandride (Rhynchophorus). Fig. 7, do. of Cryptorhynchus. Fig. 8, do. of Balaninus. Fig. 9, do. Ophryastes. Fig. 10, do. Thecesternus. Fig. 11, do. Dendroctonus.

When the coxæ are contiguous, the point of the prosternum is visible behind them, but is none the less perfectly enclosed by the growth of the side pieces to the median line.

Another evidence of the inferiority of type of the Rhynchophora, which has not been mentioned, is seen in the functions performed by the beak, which in the lower groups, especially in the female, becomes greatly elongated. The occurrence of corneous exserted ovipositors in other orders of insects is not rare: a few species of Coleoptera (certain Valgus, for example) have the last abdominal segment prolonged, simulating such an organ. But it was reserved for the Rhynchophora to exhibit a degradation of type, by which a function, peculiarly appropriate to the posterior extremity of the body, is performed by the head: the elongated beak becoming in fact the ovipositor.

Thus the inferiority of grade, evidenced in other series of Coleoptera by the softness of the integuments, or by the permanence of larval forms, chiefly in the abdomen and coxæ, is in the Rhynchophora manifested by the transfer of a function from the posterior to the anterior part of the body, and the linear extension of the latter, in accordance with this 'change of base.'

The principles of classification of Rhynchophora, and their division into families will be discussed in a subsequent memoir. It is, however, proper to observe that the peculiar construction of prothorax above described as characteristic of the Rhynchophora, is not exhibited in the Bruchidæ, which family, as observed by Lacordaire (Gen. Col. vii, 600), should be viewed as closely related to, if not actually a portion of, the great family Chrysomelidæ.

ART. V.—*On the Morphological value and relations of the Human Hand;* by BURT G. WILDER, S.B., M.D.

[Abstract of a paper read before the National Academy of Sciences, Aug. 8, 1866.]

THE morphological relations of the human hand are of three kinds.

1st, Its *special homology* with the terminal segment of the anterior extremity in other vertebrates.

2d, Its *general homology* as a part of the skeleton; which can be fully enunciated only after a decision as to the morphological relations of the scapular arch of which it is an appendage.

3d, Its *polar homologies* with the corresponding parts on the *opposite side* and at the *opposite end* of the body. That with the other hand is universally regarded as one of *symmetry* or *antagonism;* that with the foot is generally called its *serial* homology, and the point under consideration is whether this is merely a serial relation and not rather one of antagonism, so as to constitute a second kind of polar homology.

The course of the argument is indicated by the following propositions.

1. The extreme diversity and confliction of opinion* as to the morphological *relations* of the human hand are chiefly due to an over-estimate of its morphological *value.*

2. This misappreciation of the morphological value of the hand is due to a non-recognition of the distinctions between the two principles, morphology and teleology.

3. Morphology is the law of internal form, of plan, of essential structure. Teleology is the law of special function which determines size, shape and general appearance.

4. Homology is morphological identity; analogy is teleological resemblance: and neither relation necessarily implies the other.

5. Morphology treats of unity of type; teleology treats of adaptation to ends.

6. Morphology alone would be law without liberty, which is despotism; teleology alone would be liberty without law, which is anarchy.

7. Morphology is conservative and tends toward centralization; teleology is radical and tends toward diffusion.

8. The two principles may be traced in all structures, but the one is often more prominent than the other.

9. With certain important qualifications it may be said that the clearest manifestations of morphology are to be observed in

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* Some idea of this diversity of opinion may be gained by reference to Dr. Cleland's brief statement of the views of various authors in the 7th edition of Quain's Anatomy, pp. 115–117, 1866, and to the remarks of Mivart, Linnæan Transactions, vol. xxv, p. 400.

organs which are *central* or *proximal*, *simple*, *rudimentary*, and *constant;* while teleology displays itself in organs which are *peripheral* or *distal*, *complicated* and *subject to variation.*

10. Man is the most perfect animal in a functional point of view, and the hand is *peripheral in its position*, *complicated in function* and *subject to variation* both in the zoological series and by arrest or excess of development: and forasmuch as it has, during all ages and by all classes of minds, been regarded as a typical illustration of perfection of detail and harmonious arrangement of parts in strict conformity to the elevated offices which it performs, *therefore to the same extent must we disregard it in our endeavor to determine questions of morphology.*

11. Hands and feet, but especially the former, are as unsafe guides to the homology of the limbs, as the cranial and caudal regions would be to the characters of a typical vertebra.*

12. In discussing the relation between the fore and hind limbs, we must free our morphological comparison from all consideration of special function.

13. The fore and hind limbs are appendages of the anterior and posterior regions of the body; and whatever general laws are observed in the body, are, on *a priori* grounds, to be looked for in the limbs.

14. Polarity, or something analogous to the polar forces of physical science, is a primary law in the formation, the structure and the general functions of the vertebrate body;† for the existence of this, evidence is furnished by embryology, anatomy, physiology, and pathology.‡

15. The anterior and posterior regions of the body are, as it were, the two poles of a longitudinal axis, and their constituent parts are more or less completely homologous, repeating each other in opposite directions like the corresponding organs upon the right and left sides.

16. This polar or antagonistic relation of similar parts may easily be traced in the proximal segments of the limbs in many mammalia; the front of the thigh and the convexity of the knee are readily compared with the back of the upper arm and the convexity of the elbow.

17. Of the two pair of limbs, the anterior is the more subject to variation and is therefore less reliable for morphological purposes.

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* On a cat with supernumerary digits; Proceedings Bost. Soc. of Nat. Hist., May 16, 1866.

† See the writings of Oken: also description of a double fœtus, by Prof. Jeffries Wyman, Bost. Med. and Surg. Journal, March 29, 1866; and classification of Herbivores, and Cephalization, by Prof. James D. Dana, this Journal, vol. xxxvii, p. 158, and vol. xli, p. 164.

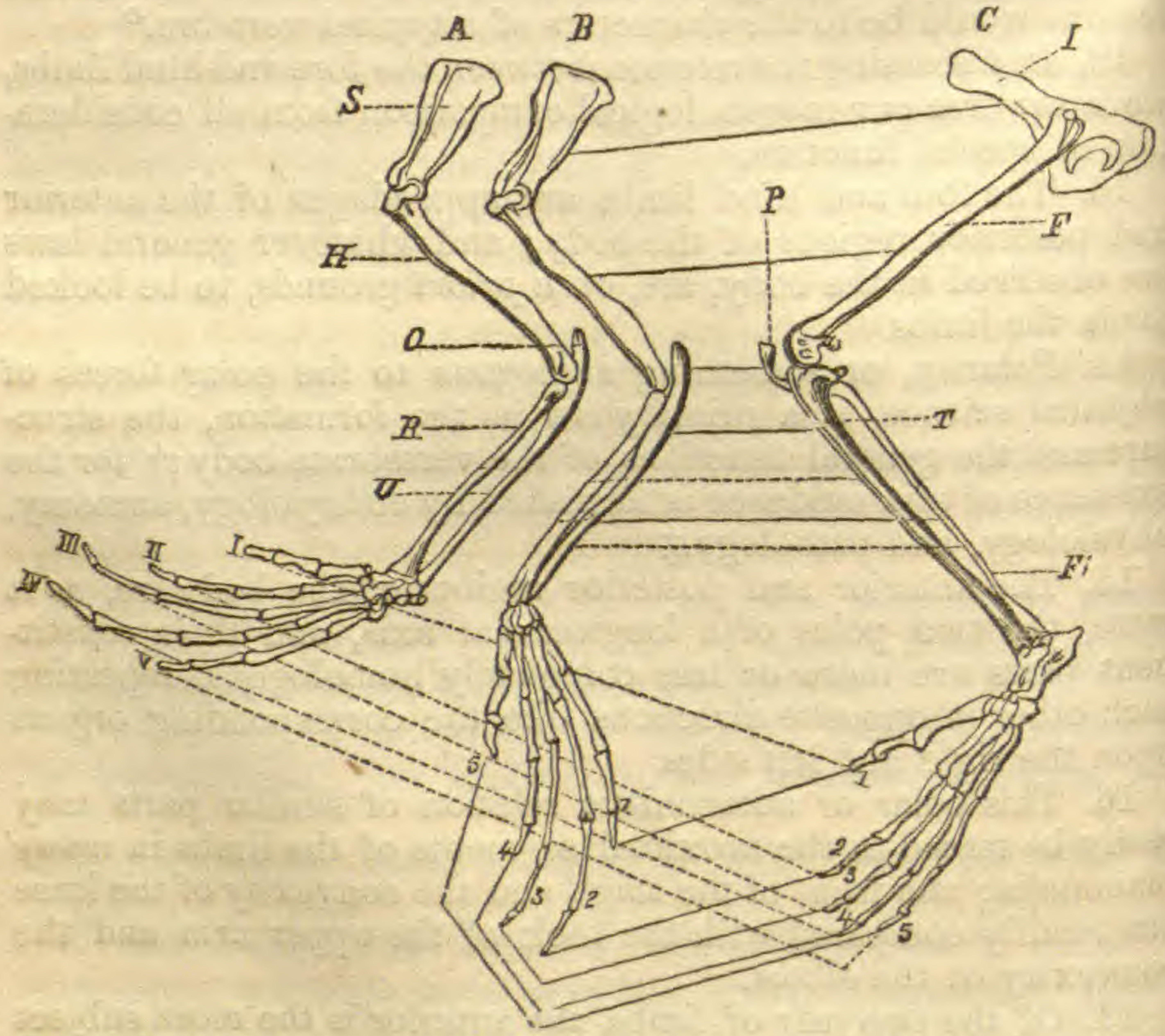
‡ See paper by the writer on Pathological Polarity, Bost. Med. and Surg. Journal, April 5, 1866, and on Morphology and Teleology especially in the limbs of Mammalia, Memoirs Bost. Soc. Nat. Hist., vol. i, No. 1, 1865.

18. By reference to the less modified hinder limb we find that, as a rule, *two contiguous segments bend in opposite directions.*

19. By comparing the proximal segments of the hinder limb with those of the fore limb, we find that *two corresponding segments in the two limbs point and are flexed in opposite directions.*

20. Conformity with these two rules is all that would be necessary for maintaining the *balance* of a *geometrical figure* or a *stationary being;* but to enable an animal to *move*, the terminal segments of both limbs must face in the same direction; in the quadrupeds this is usually accomplished by a rotation of the radius upon the ulna so as to face the palm backward, or as in the Aye-aye *inward*, like the sole.

Limbs of left side of Aye-aye (*Cheiromys Madagascariensis* Cuv.), (altered from Owen.)*



A, Fore-leg in *natural attitude*, the hand being more or less *pronated.*

B, Fore-leg in *normal position*, the hand *supinated* so as to be symmetrical with the foot.

C, Hind-leg. S, Scapula; I, Ilium; H, Humerus; F, Femur; O, Olecranon; P, Patella; U, Ulna; T, Tibia; R, Radius; Fi, Fibula.

Homologous parts are joined by continuous lines. Analogous parts are joined by dotted lines. The homologous digits of B and C are numbered 1, 2, 3, 4, 5, starting from the so-called little finger and great toe. The Roman numerals attached to the digits of A indicate their analogies with those of C.

* **Monograph of the Aye-aye, plate vii: Comp. Anat. and Physiology of Vertebrates, vol. ii, fig. 343.**

21. This is the *natural attitude* of the terminal segments of the fore-limb, but that it is not a *normal position** in which they may be compared with their posterior representatives, is seen from their want of conformity to the principles manifested by the less modified hinder limb and by its own proximal segments (Propositions 18 and 19), and also from the more or less complete crossing of the two bones of the fore-arm, while those of the leg are parallel with each other.

22. These three discrepancies are wholly removed by *supinating the hand* and placing it, *palm downward with the fingers pointing backward* and the *wrist in front* just as the toes point forward and the heel is behind.

23. The *ulna* is now wholly upon the *inner* side of the fore-arm and corresponds to the *tibia* while the *radius* corresponds to the *fibula;* their variations as to size and shape and their being soldered together in many species are all teleological modifications and ought not to enter into the discussion of a morphological relation.

24. The *thumb* is thus left upon the outer side of the hand and corresponds by position with the *little toe*, while the *little finger* is upon the inner side and corresponds with the *great toe.*

25. These correspondences are, in my opinion, the true *homologies* while the relation between the ulna and fibula, the radius and tibia, the thumb and great toe are merely *analogies* and dependent upon teleological modifications.

The paper contained a more extended discussion of some points and a review of the later European memoirs upon the subject; but in the hope that we may shortly be favored with the views of Prof. Jeffries Wyman upon the important questions involved, the writer confines himself for the present to the foregoing abstract with the following additions as the result of subsequent investigations.

A. The conclusion reached as to the normal position and homology of the thumb, though contrary to the common opinion, is confirmed by all purely morphological considerations.

B. The lack of exact correspondence between the carpal and tarsal bones in most mammalia and between the nerves and the arteries in the human hand and foot where alone they have been compared, is due to teleological modifications, the necessity for which is yet to be explained.

C. The difference in the number of phalanges, which has always been looked upon as a very essential distinction between the thumb and great toe and the other digits, is really, like the

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* For a forcible statement of the necessity for distinguishing between the natural attitude and the normal position of animals, see Agassiz's contributions to the Nat. Hist. of U. S., vol. iii, part 1, p. 76; it throws a great light upon this relation of the limbs.

generic variations as to the number of the digits themselves, a difference of *quantity* and therefore teleological in its character.

D. Finally, even if there were not many vertebrates in which this difference does not exist, and if there were not on record several cases of human thumbs having three phalanges, yet, unless we are prepared to sacrifice position to quantity, we have no more reason for denying the homology of the thumb and great toe with the little toe and little finger respectively than we have for denying a homology between the third finger of man and that of a whale because the former has some additional phalanges, or between the foot of man and that of a dog because the former is composed of five digits while the latter has but four.

ART. VI.—*On the Classification of the subdivisions of McCoy's Genus Athyris, as determined by the laws of Zoological Nomenclature;* by E. BILLINGS, Paleontologist of the Geological Survey of Canada.

[Read before the Nat. Hist. Soc., Montreal, March 25, 1867.]*

EVERY naturalist who has studied the paleozoic brachiopoda is aware that there exists a very great diversity of opinion with regard to the classification of the several sections into which the old genus *Athyris* has been divided. The arrangement which I and some others have adopted is, in substance, the same as that proposed by Mr. Davidson in the first edition of his "General Introduction," published in 1853.† Although this has been ob-

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* After the reading of this paper the subject was discussed by some of the members of the Society. The following is from a short report published in the newspapers at Montreal: "After the paper was read, Dr. P. P. Carpenter said that he thought that Mr. Billings had clearly established his point, and gave an account of the history of a committee appointed by the British Association to make laws to regulate scientific nomenclature, of which committee he was a member. Mr. Whiteaves stated that he was satisfied with the correctness of the view Mr. Billings had taken, and made some remarks about scientific nomenclature, and upon some structural points in the shells of the genus in question. Principal Dawson deplored the confusion that has arisen through conflicting views on the question of nomenclature, and agreeing with Mr. Billings in the conclusion he had come to, said that this communication was valuable inasmuch as it cleared up a question that had hitherto been rendered obscure."

† Modified by separating *Merista* thus:

GENUS.	TYPE.
Athyris McCoy, 1844, - - - - -	*A. tumida* Dalman.
Spirigera D'Orbigny, 1847, - - - -	*S. concentrica* von Buch.
Merista Suess, 1851, - - - - -	*M. Herculea* Barrande.

The recent classification differs from the above as follows:

Meristella Hall, 1860, - - - - -	*A. tumida.*
Athyris or *Spirigera*, - - - -	*S. concentrica.*
Merista, - - - - - - -	*M. Herculea.*

According to this, either *Athyris* or *Spirigera* must be suppressed, in order to make room for *Meristella*. See this Jour., [2], xxxi, 292, xxxiii, xxxvi, ii.

jected to by several distinguished paleontologists, and in consequence thereof, abandoned by its author, yet I believe that on a careful examination of all the circumstances, it will be found to be perfectly just toward the parties concerned, and in no respect inconsistent with the rules of zoological nomenclature. It was the first subdivision of the genus published, and should therefore take precedence over all others.

Previously to 1853, *Athyris* was only known as a single large genus of brachiopoda which included such forms as *Terebratula concentrica* von Buch, *T. tumida* Dalman, and *T. Herculea* Barrande. In that year Mr. Davidson divided it into two smaller genera, confining the name *Athyris* to that section for which it was most appropriate, with *tumida* or *Herculea* for the types; and adopting *Spirigera* D'Orbigny for the other type, *T. concentrica.* It was afterward found that *Athyris*, as then re-defined, included two genera, and in consequence it has been again divided by separating all those typified by *T. Herculea* under the name of *Merista*, a genus proposed, but not clearly characterized by Prof. Suess, in 1851. This is the classification which I believe to be the true one. While discussing it I shall, throughout this paper, when I may have occasion to refer to the species above-named, designate them, *Athyris tumida*, *Spirigera concentrica*, and *Merista Herculea.*

Those who are opposed to this arrangement contend, that as all the species which McCoy placed in the genus, at the time he first described it, belong to the group typified by *S. concentrica*, the name *Athyris* must be retained for that group, and cannot now be transferred to the other section of which *A. tumida* is the type. This reasoning, according to my views, can only hold good in case it be first proved that McCoy specially confined the genus to species having the generic characters of those in his original list, or pointed out one of them as the type, or drew up his diagnosis in such a manner as to exclude *A. tumida.* In this paper I shall endeavor to show:—

1. That McCoy did not limit his genus to the species first placed in it.

2. That on the contrary he and other naturalists understood it to include both *A. tumida* and *S. concentrica.*

3. That according to the laws of zoological nomenclature the subdivision made by Davidson in 1853 cannot be set aside.

4. That Davidson's classification has been adopted into several works, some of them of great influence and wide circulation.

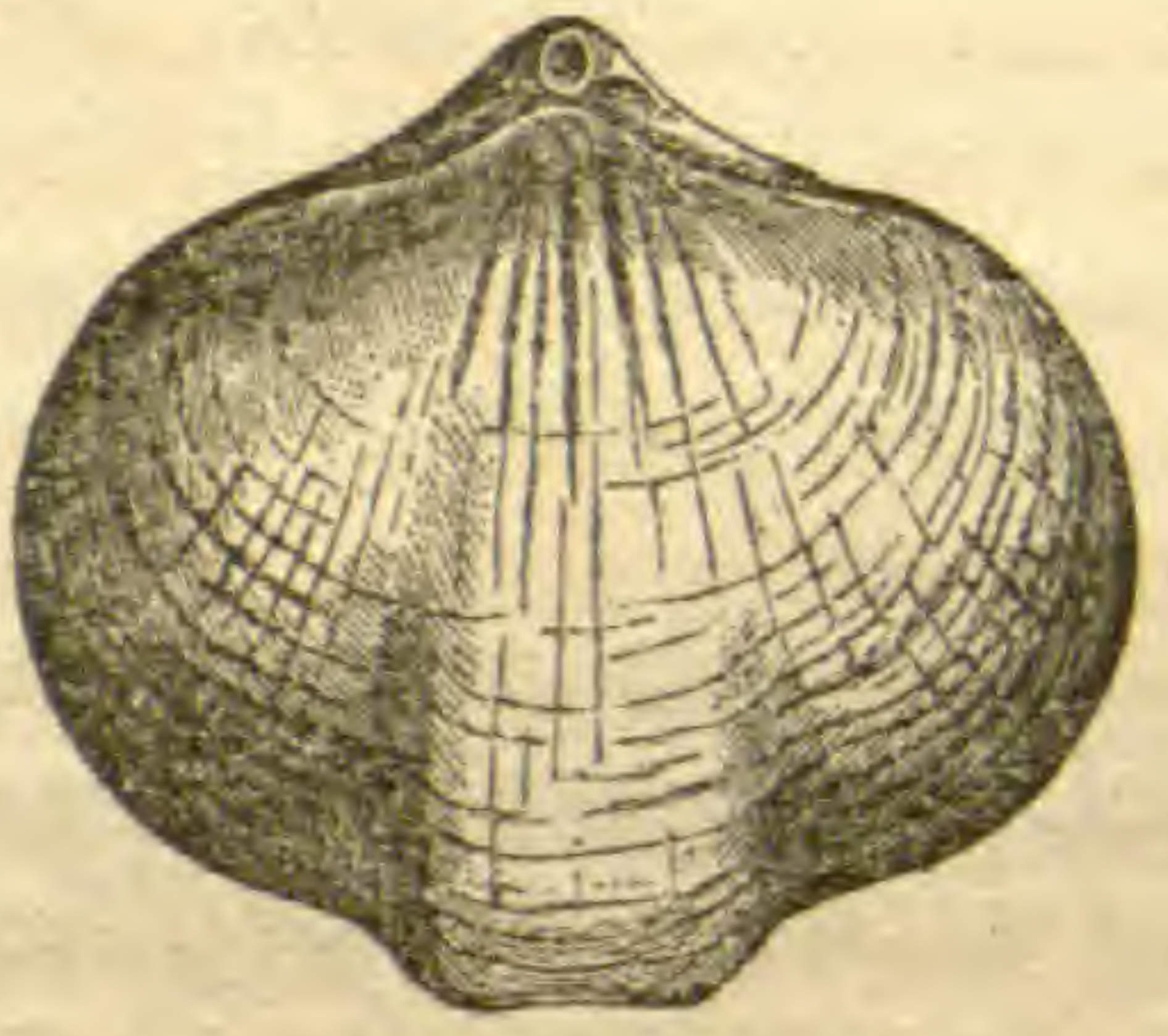
In order to prove the above propositions, I shall give the more important facts of the history of the genus, with McCoy's original figure, and shall quote some of the laws above mentioned in full. Much of this, of course, belongs to the common stock of knowledge of all paleontologists conversant with the fossils of the older rocks, and might be thought superfluous. But the question is somewhat complicated and cannot well be decided, unless in view of all the circumstances. Besides this, it is one upon which any good naturalist is perfectly competent to give an opinion, although specially engaged in other departments. Few of these have access to works on paleozoic fossils, and therefore for the convenience of such as may feel inclined to investigate the subject, it is desirable to bring all the facts togather.

There is no dispute about the extent of the genera, and therefore, the details of the internal characters need not be given. It is purely a question of Natural-History Ethics, if I may be permitted to use such a term.

1. *History and extent of the original Genus.*—The original description was published in the " Synopsis of the Carboniferous Fossils of Ireland" in 1844. From this work I shall make some extracts, and shall introduce along with the original figure two others to further illustrate the subject.

1.

2.



3.

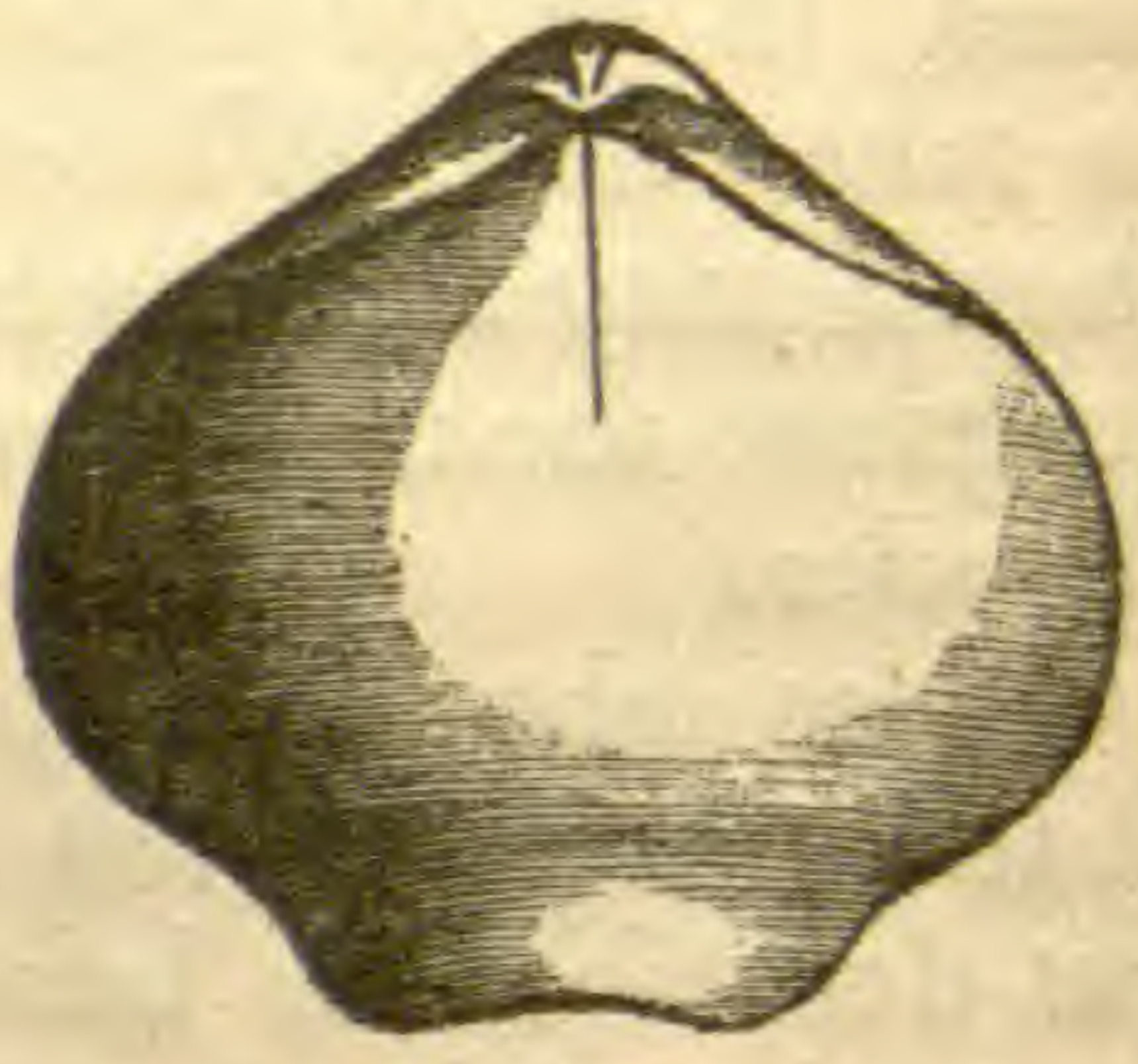


Fig. 1—Copy of the original figure given by McCoy (without a specific name) to illustrate his idea of the general form of an *Athyris.*

Fig. 2—*Spirigera concentrica* von Buch. The form is copied from Davidson's Monograph of the British Devonian Brachiopoda, pl. III, fig. 13, Pal. Soc. for 1862. The right-hand side is, in this copy, a little restored, and the aperture in the beak made larger than it is in the original figure.

Fig. 3—*Athyris tumida* Dalman. Copied from Davidson's " General Introduction," pl. VI, fig. 73.

The following extracts are from McCoy's work above referred to:—

"The family *Delthyridæ* appears to be divided into the five following genera: 1. *Spirifera* Sow., composed of those longitudinally-ribbed species, in which the hinge-line is equal to, or exceeds the width of the shell, the cardinal area with parallel sides, the cardinal teeth of the ventral valve (now called the dorsal valve) large, spirally rolled, and having a triangular foramen beneath the beak of the dorsal (ventral) valve. 2. *Martinia* McCoy, or the smooth Spirifers, in which the hinge-line is less than the width of the shell, and the cardinal area triangular. 3. *Athyris* McCoy, in which there is no vestige of either foramen, cardinal area, or hinge-line. This remarkable genus is frequently confounded with those shells usually named *Terebratula*, in the older rocks, but is distinguished by the large, spiral appendages, which are wanting in the other group. 4. *Brachythyris* McCoy, in which we find the longitudinally-ribbed surface of *Spirifera*, united with the short hinge-line of *Martinia*. 5. *Orthis* Dal., in which there are no spiral appendages, the hinge-line and striæ frequently spinose (as in *Leptæna*), and the cardinal area common to both valves, and its sides inclined toward each other at its angles; dorsal valve smallest."—*Op. cit.*, page 128.

On page 146 of the same work, he thus concisely describes the genus:—

"*Gen. Ch.*—Nearly orbicular, small; no cardinal area or hinge-line; spiral appendages very large, filling the greater part of the shell.

"This very interesting group possesses all the external characters of the *Terebratulidæ*, united to the internal structure of the Spirifers, to which latter family it truly belongs. Professor Phillips is the only author who has recognized the group: he forms of it his last division of the genus *Spirifera*, but gives no characters to distinguish it from *Terebratula*; the internal structure is, however, a sure guide."

The above is all that he wrote about the genus at that time; and it will be perceived, that he does not point out any particular species, as the type: and farther, that there is nothing in his remarks from which it can be inferred that he knew anything about the genera into which the group was afterwards subdivided. Consequently, it is impossible that he could have intended to confine the genus to any one of them; as is now affirmed by some of the naturalists who are opposed to the classification advocated in this paper. Instead of excluding species with an imperforate beak such as *A. tumida,* the etymology of the word *Athyris* (without a door or opening), the expression, "in which there is no vestige of either foramen, cardinal area or hinge-line," and, also, his typical figure all induce the belief that he had before him one or more forms with the beak entire. This is rendered certain by what he says on page 147. Speaking of what he calls *A. concentrica*, he says: "This species is not uncommon; it is figured in the Bull. de la Soc. Géol. de France, with a perforated beak as in *Terebratula.* I have, however, seen numerous specimens with the beak entire and imperforate, as in the other Paleozoic species." It is highly probable from all this that he had in view such Silurian forms as *A. tumida.* This latter species is so common that it is almost certain that such a collection, as he was then engaged upon, would contain one or more specimens.

If we take the paragraph (No. 3) as a part of the generic description, then *A. tumida* is included. If, on the other hand, we confine ourselves to the extract from p. 146, it is not excluded, as there is no reference made there to the structure of the beak. This latter diagnosis is sufficiently comprehensive and general in its terms to include *Athyris*, *Spirigera* and *Merista.* He did not place *A. tumida* in the genus, for the reason that his work was confined altogether to the Carboniferous fossils, among which it does not occur. But he did so afterward when he described Professor Sedgwick's Silurian fossils, as will be shown farther on. He was wrong in supposing that all the species were imperforate, a matter of little consequence, as it was simply an error of observation which does not vitiate. Had the genus turned out to be not capable of subdivision, all that could be done now with this error would be to strike it out. There was sufficient in his diagnosis to indicate what group of fossils was intended. He was also wrong in supposing *S. concentrica* to be a Carboniferous fossil: it is Devonian. It may be that he mistook some other species with an imperforate beak for that. It will be seen farther on that Prof. King made a similar mistake with respect to this very species, having taken *T. scalprum* Barrande, for it; an error which was detected by Mr. Davidson. Altogether, he referred eleven species to the genus, several of which have been shown to be synonyms.

In the same work he proposed another genus, *Actinoconchus*, but as it was founded on error, he afterward withdrew it, and added it to *Athyris*. (Brit. Pal. Foss., p. 436). All scientific works abound more or less with such misconceptions.

That the genus was understood by other naturalists to include *A. tumida* is proved by the following facts. It is well known that the genus *Spirigera* was proposed by D'Orbigny, in 1847, simply as a substitute for *Athyris*, on the ground that this latter name implies the absence of a foramen, and is, therefore, not appropriate for species with a perforated beak. It is quite clear that D'Orbigny considered his genus to be precisely the same in extent as *Athyris*. All the species, therefore, which he placed in *Spirigera* he regarded to be fairly within the group, and it is unquestionable that he would have referred them all to *Athyris* had not that name appeared to him objectionable. I have not seen his original description in the "Annales des Sciences Naturelles," referred to by Mr. Davidson, in the extract given below, but in the "Paléontologie Française," vol. iv, page 357, he says: "This division has already two generic names which we cannot preserve, because they are in complete contradiction with zoological characters." The two genera referred to were *Athyris* and *Actinoconchus*.

He specially selected *T. concentrica** for the type of his genus, and therefore if *Spirigera* be retained at all it must be for that section. He refers to his "Prodrome" for a list of the species, and we have thus only to examine this list in order to ascertain his idea of the extent of the genus. They are the following, taking them in the order in which they are published:

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* "Le type est *T. concentrica* de Buch. Toutes les espèces avec leur synonymie se trouvent dans notre *Prodrome de paléontologie stratigraphique.*"

S. Ceres, vultur, Circe, passer, Herculea, harpya, Hecate, tumida, concentrica, Helmersoni, Puschana, decussata, plebeia, Ferronesensis, Ezquerra, Hispanica, Toreno, subconcentrica, Pelapayensis, Campomanensis, Mayendorfi, Roissyi, serpentina, lamellosa, ambigua, Blodena, planosulcata, expansa, pentaëdra, pectinifera, trigonella, quinquecostata, quadricostata, tricostata and *cristigalli.*

Several of the above species do not belong to the group. This list shows that D'Orbigny regarded the genus as including not only the types of *Athyris* and *Spirigera* but also that of the genus *Merista* (*M. Herculea*) which I shall notice farther on. I think it quite certain that had D'Orbigny been aware that the genus was capable of subdivision, he would have retained *Athyris* for one of the groups which have the beak imperforate. Indeed, according to the laws of nomenclature, he could not have done otherwise with any probability of producing a permanent classification.

In a valuable paper, read before the Geological Society of France, in May, 1848, on the Brachiopoda of the Upper Silurian rocks of England,* Mr. Davidson made the following observations on D'Orbigny's genus:

> Vient ensuite le genre *Spirigera* que le même auteur établit pour les coquilles qui possédent des spires internes placeés de la même manière que les *Spirifer*, mais qui ont des appendices et des détails d'organisation essentiellement différents. Ces espèces, parmi lesquelles nous trouvons les *Terebratula, tumida, Circe, concentrica, subconcentrica, Roissyi, pectinifera, ambigua, Helmerseni, Pelapayensis, Campomanensis, Ferronesensis, Ezquerra, Hispanica,* ont déjà été distinguées par M. de Verneuil comme devant former une section à part, qu'il a nommée la section des *Concentricæ.* Je suis de l'opinion de M. d'Orbigny qu'elles doivent constituer un genre. L'étude minutieuse que M. Bouchard a faite de la *Terebratula concentrica* ne m'en laisse aucun doute; mais ce genre n'ayant pas encore été convenablement caractérisé, je m'abstiendrai de l'adopter dans ce petit mémoire qui n'est pour ainsi dire qu'un résumé d'un plus grand travail que je publie en ce moment dans le *London Geological Journal.*

Upon the above I shall only remark that it is quite clear that Mr. Davidson then regarded *S. concentrica* and *A. tumida* as congeneric; and that whatever new genus might be established, it would include both species.

In 1852, McCoy, in the 2nd Fasciculus of the "British Paleozoic Fossils," page 196, re-defined *Athyris* as follows:—

> "*Gen. Ch.*—Nearly orbicular or ovate, both valves convex; no cardinal area, foramen, or hinge-line: spiral appendages to beak of entering valve very large, nearly filling the shell; a strong mesial septum in the rostral part of entering valve; dental lamellæ moderate; tissue of shell apparently fibrous.

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* *Mémoire sur les Brachiopodes du Système silurien supérieur d'Angleterre,* par M. Th. Davidson, Bull. Geol. Soc. Fr., v, pp. 309, 314.

"One specimen (of *A. tumida*) shows the pallial and ovarian impressions to be thick, numerous, and dichotomising frequently from beak to margin."

In the work cited and in the 3d Fasciculus, we find the following species:—*A. tumida*, *S. concentrica*, *ambigua*, *De Roissyi*, *expansa*, *globistriata*, *globularis*, *gregaria*, *paradoxa*, *pectinifera*, and *squamigera*. This shows clearly enough his views of the extent of the genus, that is to say, that as it was then understood, it included both *A. tumida* and *A. concentrica*. In commenting on this, Prof. Hall says:—"The fact that McCoy cited this* as an Athyris, no more renders it an *Athyris* than it was made *Atrypa*, by being thus described by Dalman; and it was just as free for the foundation of a genus after the citation of McCoy as before." This is true enough, in part. It was free for the foundation of a genus until 1853, when Davidson used it for that purpose; but since 1853, it has never been free.

The above is quite sufficient to prove my first and second propositions.

I am not aware that any thing else of much importance, with the exception of what relates to *Merista*, having been published up to 1853, when Davidson's excellent work, the "Introduction to the Classification of the Brachiopoda," made its appearance, in which the genus was first subdivided. But, before entering upon this, I shall notice the remarks of Prof. Suess, on the genus *Merista*.

This genus was proposed by Prof. Suess, in 1851, but he did not then sufficiently characterize it. The following is all that I can find, relating to it, that was published previously to 1853.

"Mr. E. Suess communicated the results of the investigations on several Brachiopods, from the Bohemian transition rocks, which had been made by him and Mr. Custos Dormitzer, of Prague. He showed that some of the forms heretofore referred to *Terebratula* had no opening in the beak, for the passage of the muscle of adhesion; and, also, that the distribution of their inner organs points to an affinity with the non-attached genus Pentamerus. These inner organs are borne by six partitions in place of a single calcareous loop; the spiral arms are not unrollable.

"Through the separation of these forms (for which the name *Merista* is proposed) from the genus *Terebratula*, an apparent contradiction in the laws of paleontological distribution is solved, since these smooth forms will now be separated, which have heretofore offered an apparent contradiction to the present views of these laws."

Lest I should not have expressed his views rightly in this free translation, I give the original in the note below.†

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* This Jour. II, xxxii, 131.

† "Herr Eduard Suess theilte die Erfolge der Untersuchung einiger Brachiopoden aus dem böhmischen Uebergangsgebirge mit, die er gemeinschaftlich mit Herrn Custos Dormitzer in Prag angestellt hatte. Er zeigte, dass mehrere bisher zu den

On page 160 of the same work, there are some farther remarks on the classification of the brachiopoda, by Prof. Suess, in which he refers to the genus *Merista.* No generic description is, however, there given. It appears also that it was again noticed in "Leonhard's Neues Jahrbuch, p. 127, 1854." I have not, at present, access to that work, and do not know whether the genus is described there or not: at all events, at the time Mr. Davidson prepared the English edition of his "General Introduction," *Merista* was not understood.

Prof. King in his "Monograph of the Permian fossils of England" (1850) proposed to restore the genus *Cleiothyris* of Phillips, apparently making it partly equal to *Athyris* McCoy. But the specimen on which this arrangement was founded, was afterward shown to Mr. Davidson, and by him identified with *T. scalprum* Barrande (now *Merista* scalprum), while *Cleiothyris* was intended by its author as a substitute for *Atrypa.* (See Davidson's Introduction, p. 85.)

2. *Subdivision of the Genus by Mr. Davidson in* 1854.—From all the facts above given it may be gleaned that in 1853, when Mr. Davidson was engaged in the preparation of his General Introduction, this group of Brachiopoda was known as a single genus but with two generic names *Athyris* McCoy, 1844; *Spirigera* D'Orbigny, 1847. Each of these was intended by its author to include the whole group. McCoy was under the impression that all the species had the beak imperforate, while D'Orbigny maintained that they were all perforated. Both authors were partly wrong and partly right. The genus was capable of subdivision, but no one had as yet undertaken that task; unless indeed, the observations of Prof. King and Suess can be so construed. With regard to the latter, as the genus *Merista* is now well understood and is different from *Athyris*, it does not affect the question. *Cleiothyris* may be considered as obsolete.

Mr. Davidson in his "General Introduction" in endeavoring to reconcile the conflicting nomenclatures of D'Orbigny and McCoy divided the genus, retaining the name *Athyris* for "forms with an apparently imperforate beak or closed foramen, variously disposed septa and largely developed dental plates." He

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Terebrateln gezählte Formen an ihrer Spitze keine Oeffnung für den Anheftungsmuskel besitzen, und dass auch die Vertheilung ihrer inneren Organe auf eine Verwandtschaft mit der ebenfalls nicht angehefteten Gattung Pentamerus hinweist. Diese inneren Organe werden von 6 Wänden, statt von einer einfachen Kalkschleife getragen; die Spiralarme selbst sind nicht aufrollbar."

"Durch das Lostrennen dieser Formen, für welche der Name *Merista* vorgeschlagen wird, von der Gattung, *Terebratula*, wird zugleich ein scheinbarer Widerspruch in den Gesetzen paläontologischer Verbreitung gehoben, da eben jene glatten Arten ausgeschieden werden, welche den bisherigen Ansichten über diese Gesetze am schroffstan entgegengestanden waren."—*Jahrbuch der k. k. geologischen Reichsanstalt, Vienna,* ii, pt. 4, pp. 150, 160. 1851.

selected two species, "*A. tumida* Dal. or *Herculea* Barrande," and specially named them as the types.

He retained *Spirigera* for the group of which *S. concentrica* is the type. As to this latter group, by whatever name it may be hereafter known, its extent will most probably always be that assigned to it in the work in question.

The genus *Athyris*, however, as there defined, included *Merista*, a circumstance which, however, as I shall presently show, in no way vitiates the arrangement. In a note, he states,—"before coming to the above conclusion, I submitted my views to Mr. Deshayes, Mr. Salter, and others, who seemed to consider that this mode of compromising the difficulty could not reasonably be objected to by the two authors principally concerned nor by the generality of Paleontologists." Op. cit., p. 86.

Afterward this classification was strongly objected to by several naturalists, who maintained that McCoy had "originally and positively" applied the name *Athyris* to the *S. concentrica* group, and, therefore, it could not be transferred to the other principal section. He, therefore, in the French edition of this introduction (1856), abandoned his first arrangement,* and substituted *Merista* and *Athyris*, at the same time transferring the latter to *Spirigera*, as in the extract given in the note below. (Op. cit., p. 101.)

Upon a careful examination of all the circumstances I think it will be found that according to the laws of nomenclature this change cannot be sustained. I shall therefore quote some of those laws and endeavor to apply them to this case.

The first rule reads thus:

> "S. 1.—The name originally given by the founder of a group or the describer of a species, should be permanently retained, to the exclusion of all subsequent synonyms."

It seems scarcely necessary to quote such a rule as this. I only do so in order to make the comment, that it is the most important of all the laws of nomenclature; and that its operation cannot be prevented in any case, by merely technical objections or by any error in the details of a generic or specific description. Provided the original diagnosis contains sufficient in substance, to enable the scientific public to identify the group, trivial errors, from which the writings of no naturalist are free,

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* "Mais ce moyen terme a été critiqué par plusieurs naturalistes qui ont insisté sur ce que le terme *Athyris* avait été originairement et positivement appliqué par son auteur a la *T. concentrica* et sur l'impropriété de l'autre dénomination pour désigner des coquelles telles que les *T. tumida, Herculea*, &c. M. Suess nous a informé (2) qu'il avait, en 1851, propose le nom de *Merista* (3) pour le groupe renferment ces derniers. J'abandonne donc la proposition que j'avais faite en 1853, et je conserve indifféremment l'*Athyris* McCoy, ou le *Spirigera* d'Orb., pour le *T. concentrica;* et *Merista*, Suess, pour les *T. tumida, Herculea, etc.* (2) *Neues Jahrbuch*, p. 62, Janvier, 1854. (3) *Jahrb. k. k. geol. Reichsanstalt*, II, IV, 150, 1851. Mentionné encore dans *Leonhard's neues Jahrbuch*, p. 127, 1854."

will not have any effect. All that can be done is to rectify; not to destroy. One of the exceptions to this rule is thus expressed in No. 11. "A name may be changed when it implies a false proposition which is likely to propagate important errors."

According to this exception if the name *Athyris* should be applied to the *S. concentrica* group there is a possibility of its falling into the list of synonyms; for, although no very important error would be superinduced, yet few naturalists can apply it to shells with a well defined foramen without feeling that such an application is to some extent, inconsistent with the purity of scientific nomenclature.

> "§ 3.—A generic name, when once established, should never be cancelled in any subsequent subdivision of the group, but retained in a restricted sense for one of the constituent portions."
>
> "4.—A generic name should always be retained for that portion of the original genus which was considered typical by the author."

This latter rule is preceded by some introductory observations which should be embodied in it as they in fact form a part of the rule itself. They are especially applicable to this case.

> "When a genus is subdivided into other genera, the original name should be retained for that portion of it *as at first defined.* Authors frequently indicate this by selecting some one species as a fixed point of reference, which they term the "type of the genus." When they omit doing so, it may still in many cases be justly inferred that the *first* species mentioned on the list, *if found accurately to agree with their definition*, was regarded by them as the type. A specific name, or its synonyms, will also often serve to point out the particular species which by implication must be regarded as the original type of the genus. In such cases we are justified in restoring the name of the old genus to its typical signification, even when later authors have done otherwise."

Now this rule bears directly on the question, because many naturalists are under the impression that the first species placed on the list must *necessarily* be regarded as the type, where the author is silent on that point. But according to the above (and common sense), it is only so if found *accurately to agree with the definition. Spirigera concentrica* does not agree either with the name *Athyris*, nor with McCoy's generic description, nor with his typical figure. Therefore it cannot be arbitrarily selected as the type, and the name *Athyris*, in consequence, retained for that group. Indeed in many instances it would be impossible that the first species placed in the genus should be the type, for the author might not have the true type in the collection under investigation.

In this instance, as before mentioned, McCoy was preparing a work exclusively devoted to Carboniferous fossils, among which *A. tumida* does not occur. In preparing his description of the genus he may, however, have had that species before him, and its imperforate beak may have had some influence.

§ 5. "When the evidence as to the original type is not clear and indisputable, then the person who first subdivides the genus may affix the original name to any portion of it at his discretion, *and no later author has a right to transfer that name to any other part of the original genus.*"

This last paragraph applies as well to the author who first subdivided the genus as to others. Once a genus is established, or subdivided, on sound principles, it becomes the property of science, and the author himself (either of the genus or the subdivision) can make no change. He may amend by striking out the errors, if any there be, but all that is true must remain.

I think that on a careful study of all the circumstances, it will be perceived that Mr. Davidson's first adjustment of this question was the most wise, the best for the interests of science, and the most just toward all the parties concerned, that could be devised. It was not inconsistent with the laws of nomenclature, but in perfect accordance with them in every particular; and, therefore, should be retained.

In one respect, however, it has been modified. *Athyris* as first defined by him, included *Merista* of Prof. Suess. This was, no doubt, due to the fact that the characters of this last named genus were not then accurately known to the scientific public. This makes little difference. *Merista* has long since been separated, with its type *M. Herculea;* leaving the other and most important group for *Athyris* with *A. tumida* for the type.

With regard to *Spirigera*, I think it can also be retained notwithstanding the following rule:—

§ "When two authors define and name the same genus, *both making it exactly of the same extent*, the latter name should be cancelled *in toto*, and not retained in a modified sense."

If the name *Athyris* had been extremely objectionable, according to the 11th rule, *Spirigera* might have cancelled it altogether. But the true principle of interpreting these laws is, that where there is any possibility at all of saving the original name it must be saved, even if the rules be strained to their utmost in that direction. The rules cannot be stretched to destroy; but they may be strongly bent in the other direction, to preserve. If a generic name should be appropriate for a large number of the species of the group to which it was originally applied, and *not very* objectionable as to a few only, I doubt that it can be changed. Such was the case with *Athyris* when D'Orbigny objected to it. More than two-thirds of the species designated by him are imperforate, and he should have retained the name for these. Some naturalists were, therefore, in favor of rejecting *Spirigera* altogether; others of retaining it. It is not, therefore, a case clearly within the rule; and as there was much doubt, the best course to take, as soon as it was found possible to do so, was taken by Mr. Davidson. He decided in favor of preserving the name.

3. *Authors who have adopted the classification.*—In 1856, Professors H. G. Bronn and F. Roemer, in the third edition of Bronn's *Lethæa Geognostica* adopted Davidson's classification and copied his diagnosis of both genera in full. They cited *A. tumida* as the type of *Athyris.* "Die typische Art ist *Athyris tumida* McCoy. (*Atrypa tumida* Dalman.) Andere Arten sind *A. Herculea* (*Terebratula Herculea* Barrande), *A. pseudo-scalprum* (*Terebratula pseudo-scalprum* Barrande), *A. scalprum* (*Terebratula scalprum* Fred. Roemer)." Op. cit., p. 331.

They also recognized *S. concentrica* as the type of *Spirigera.* "Die typische Art ist *Sp. concentrica* (*Terebratula concentrica* Bronn). Andere Arten sind *Sp. pectinifera* (*Atrypa pectinifera* Sowerby), aus dem Zechstein, *Sp. Roissyi*, (Sp. de Roissyi Levéillé)," &c., Op. cit., p. 332.

In the same year Eichwald placed *A. tumida* in *Athyris* and *S. concentrica* in *Spirigera.*[*]

In 1860 he also introduced the same classification in his great work on the Paleontology of Russia. The Russian species are *A. tumida*, *didyma*, *ungula*, *cassidea*, *S. concentrica* and *ambigua.*[†]

In my studies of the Canadian Brachiopoda I had no occasion to describe any species of this group until 1859, when I commenced a series of papers on the Devonian Fossils of Canada West. At that time I had not fully investigated the subject, but understood from a paper published by Mr. Davidson in the "Geologist" (vol. 1, 456), and also from Woodward's "Manual of the Mollusca" (p. 223), that *A. tumida* and *S. concentrica* were thought to be inseparable.[‡] Not feeling perfectly satisfied that this was the correct classification, I prefaced my descriptions with the following remarks:—

Genus ATHYRIS,—McCoy.

"There is much difference of opinion as to the propriety of retaining this generic name. It implies that the shells have no foramen in the ventral valve, and yet many are placed in the genus which have the beak distinctly perforated. Some paleontologists are, therefore, in favor of using D'Orbigny's appellation *Spirigera* instead of *Athyris.* Nearly all of the Silurian species, and some of those from the Devonian rocks, have the beak so strongly incurved, that no foramen can be seen. For such, at

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[*] Beitrag zur geographischen Verbreitung der fossilen Thiere Russlands. Bull. Soc. imp. Nat. Moscou, vol. xxix, pp. 419, 422.

[†] *Lethæa Rossica*, vol. ii, p. 731 (*Athyris*); p. 735 (*Spirigera*).

[‡] In this work Mr. Woodward separates *Merista* (although with doubt) as a subgenus, and refers *A. tumida* to *Athyris.*

least, the name *Athyris* does not appear to be very inappropriate. Mr. Davidson still retains it, not only for those which have the foramen concealed, but also for those with it open. It appears probable that the genus will sooner or later be sub-divided, and in that case *Athyris* might be retained for the species with closely incurved beak, and *Spirigera* for some of the others. I shall give some account of the generic characters of this group of shells in another article. The following species are placed in the genus provisionally."—*Canadian Journal*, [2], vol. v, p. 273, May, 1860.

In that paper I described two species with closed beaks, *A. clara* and *A. Maia*, which, no doubt, belong to the genus. The others with perforated beaks, I marked doubtful, thus:—A. (?) *scitula* (Hall); A. (?) *Clusia*, n. sp.; A. (?) *unisulcata* (Conrad); A. (?) *rostrata* (Hall); A. (?) *Chlöe*, n. sp.*

I think it the same as the species called *Meristella Doris* by Prof. Hall (13th Reg. Rep., p. 84, 1860). I doubt that any of the others belong to either *Athyris* or *Spirigera.*

Afterward Prof. Hall (13th Reg. Rep., p. 74) proposed to establish a new genus *Meristella*, precisely identical with *Athyris*, as re-defined by McCoy, in 1852. His diagnosis reads thus:—

"Shells variable in form, oval, ovoid, orbicular or transverse. Valves unequally convex, with or without a median fold and sinus; beak of the ventral valve apparently imperforate, incurved over the beak of the smaller valve; area none; valves articulating by teeth and sockets. Surface smooth, or with fine concentric lines of growth and fine obsolete radiating striæ, which are usually more conspicuous in the exfoliated shell. The interior of the dorsal valve is marked by the presence of the longitudinal septum, and the upper part of the ventral valve by a deep subtriangular muscular impression which unites with the rostral cavity."

Now I hold that instead of proposing a new genus, he should have retained the original name *Athyris;* because his proposition amounts to a subdivision of the group, and according to the laws of nomenclature he should have applied the old name to that portion for which it is most appropriate, as had been done six years before by Davidson. As soon as this new arrangement was published, I re-investigated the subject; and perceiving that it amounted to nothing more than a restoration of Davidson's

* I now think that *A. clara* is the same as Prof. Hall's *Meristella nasuta*, but am not quite sure that it is Conrad's species. *A.* (?) *scitula* was afterward found to belong to a new genus described by me under the name of *Charionella.* (Op. cit., vol. vi, p. 148, March, 1861). It is not *Atrypa scitula* Hall, a point on which I was not certain at the time, as will be seen by the description, which reads thus:—

"The above figures represent different views of two specimens of a species which appears to me to be identical with that figured in the work above cited. It varies greatly in size. The length of the largest specimen that I have seen is seventeen lines, the greatest width fourteen lines, depth eight lines. The smallest is about two lines in length and many of intermediate sizes have been observed to make out the series. It is not certain that this species belongs to the genus *Athyris.*" Op. cit., p. 30.

former classification, but with a change of names, I declined to adopt it. In all the publications of our Survey, in which species of this group are described or figured, *Athyris* is used instead of *Meristella.*

On the merits of this classification, a note in this Jour., II, xxxiii, 130, expresses the views advocated herein. The following is an extract therefrom:—

> "This is the classification which the writer of the criticism maintains should be sustained, and we cannot see any reasonable objection to it. It is perfectly just toward both McCoy and D'Orbigny. It inflicts no injustice on any other author. It is not inconsistent with purity of zoological nomenclature, or in any way injurious to science. It does not require any modification in either of the original definitions. The typical species are central and dominant forms of two different groups of species which together form one larger general group. *Athyris*, under this arrangement, is the generic name of that group which has *A. tumida* for its type. *Spirigera* is a perfectly unexceptionable name for the other group, of which the typical form is *S. concentrica.* Prof. Hall's proposed genus *Meristella* is precisely identical with the genus *Athyris* in its restricted sense (as above explained), and cannot be admitted until some good reason is shown for setting aside Davidson's arrangement. It belongs to Prof. Hall to place this reason before the public in a clear and unsophisticated manner. If he succeed in maintaining his point, then he will establish a classification for this group of fossils far inferior to that proposed by Davidson. *Spirigera* must be suppressed, and *Athyris* must take its place, and thus stand as the generic appellation of a group of fossils for which it is not appropriate. We hold that this change is not necessary, and as it would, if adopted, be injurious to science by affecting the purity of zoological nomenclature, it cannot be maintained."

ART. VII.—*Experiments on Itacolumite, (Articulite), with the explanation of its flexibility and its relation to the formation of the Diamond;* by CHARLES M. WETHERILL, Ph.D., M.D., Professor of Chemistry in the Lehigh University.

THE rock which derives its name from the mountain Itacolumi in Brazil is certainly one of the most interesting with which we are acquainted. As the companion (probably the matrix) of the diamond, a study of its origin and nature might possibly solve the problem of the formation of that gem; and its flexible character is at such variance with our ordinary experience of the stability of rock, that it is wonderful to those even who are most familiar with it.

According to the authorities, itacolumite is a laminated quartz rock of the talcose series, owing its lamination to a little talc or mica (Dana), to which material its flexibility is also due (Dana, Percy and others). It occurs in extensive formations in Brazil, the Urals, and in the United States in Georgia, and in North Carolina, and appears particularly to accompany the diamond.

The specimens which I have examined are: 1st. A number of slabs of various size from Saraw Mt., Stokes Co., N. C., given to me by Captain Samuel W. Dewey. 2d. Small fragments of a large slab in the Museum of the Smithsonian Institution, to which it was presented by Charles DeSelding, who obtained it in Rio de Janeiro, its locality being Minas Geraes, the celebrated diamond region of Brazil. These two specimens have the same general appearance; with the exception of color, which for the North Carolina rock is a light yellow, and for the Brazilian mineral a light reddish brown, and of the granular condition, which is finer for the North Carolina specimen.

They may be split more readily in one direction yielding slabs, and there are occasionally small fissures at right angles to these layers. There is also in one of my specimens a plane forming an angle of 15° with the plane of readiest cleavage and perpendicular to the planes of the fissures. It appears to be a joint and is covered with small crystals of quartz.

Scattered through the rock are small scales of mica which are comparatively few in number but of uniform size, thin, and determine the cleavage of the rock. These plates lie in parallel planes, as they would settle naturally from a liquid. Where they are abundant in any plane the rock splits there readily. If a piece of the itacolumite, thus split, be rubbed down perpendicularly to the cleavage plane, no scales of mica are perceived upon this new surface, because the observer is looking at the edges of the micaceous plates, but the lamellar nature of the rock is thus made very apparent.

The chief constituent of the rock under the micrôscope is quartz in very sharply fractured and fine grains, together with a little mica. Occasionally are to be seen very minute black grains. One specimen when rubbed down shows small pieces of compact white quartz, giving it the appearance of a section of sausage. The specific gravity of the North Carolina specimen, taken in the ordinary manner, is 2·61; but 2·69 after freeing its pores from air by a vacuum [sp. gr. of quartz 2·65]. The analysis yields the following results:

Vol. at red heat (water), - - -	0·17
Silica, - - - - - - - -	95·89
Sesquioxyd iron, - - - - -	2·78
Lime, - - - - - - - -	0·84
	99·68

Besides which, the qualitative analysis yielded traces of KO, NaO, MnO, MgO; but no Al_2O_3. The ferric oxyd, obtained also by attacking another portion of mineral by hydrofluoric acid, was 2·03 p. c. The iron is not distributed very uniformly through the rock, as may be readily seen by an inspection of specimens.

I found it impossible to separate completely the mica from the quartz by edulcoration. When the result of the washing is examined with the microscope, scales of mica are seen, generally colorless, but sometimes dark brown, and all polarizing light, as do also the grains of quartz.

This fine edulcorate when heated on platinum foil B.B. cakes together slightly, and a slight dust adhering to the platinum does not fairly melt but exhibits signs of intumescence. With salt of phosphorus very fine grains of silica are seen floating in the bead. With borax a clear glass without intumescence results. An experiment for HFl with the itacolumite mica yielding negative results.

The mica examined with the spectroscope gave the reactions of KO and NaO only. No different result was obtained after the mineral had been attacked by liquid hydrofluoric acid, and the residue evaporated to dryness with sulphuric acid before exposure to the flame.

The relative hardness of the siliceous grains in the mineral appears to be that of agate which may be scratched slightly by them. On one occasion the bottom of an agate mortar received a very decided scratch which gave color to the supposition of a minute diamond as the cause. The rock is quite porous when compared with other sandstones; water placed in an excavation will filter very readily through the stone, even in a direction perpendicular to the plane of stratification. Gases diffuse very easily through these pores; if a slab of the itacolumite one quarter of an inch in thickness, be cemented to the top of a glass cylinder, which is then filled with hydrogen, water rises very rapidly into the tube.

When the mineral is raised to a red heat, it acquires a red color when cool; when plunged hot into water it does not become more friable. Under the HO flame it fuses to a nearly colorless glass. Heating to redness does not impair the flexibility of the stone.

The specimen from Brazil was not analyzed. It presented the same physical character as the North Carolina mineral. Its color was different, being reddish brown.

In the Brazil sandstone, the siliceous grains are larger. To the eye the quantitative relation of the silica to the mica is the same for both specimens; if there be any difference, it is in favor of a somewhat larger proportion of *mica* in the Brazilian itacolumites.

Explanation of the flexibility.—The flexibility of this rock is attributed universally to the mica which it contains, an inference which the microscope shows to be unwarranted. This flexibility is due to *small and innumerable ball and socket joints,* which exist throughout the mass of the stone very uniformly. Each joint permits a slight movement which is always greater in one direction. The accumulation of joints suffers a limited motion in every direction. This mobility is not perceptible in thick slabs unless they are large as to their other two dimensions. From such a slab it is easy to obtain a small and thin piece in which the flexibility may be observed; and the thinner the section the greater is the motion. Where small joints or fissures occur, the motion is greater at those points.

This jointed structure is so wonderful that it would warrant the name "articulite" to be given to the mineral, especially if we should find it again in other sandstones by observing them in very thin slabs.

To determine the nature of the motion, at first, various thin sections of the stone were taken, cut in three directions, viz: one parallel to the plane of stratification, one perpendicular to this plane, and one perpendicular to each of the above planes.

The sections were made by cementing layers of the rock upon a glass slide with shellac, rubbing down to the required thinness upon a slab of the itacolumite, and removing the resin by alcohol.

These sections were fastened to a piece of cork in such a manner that they might be moved, and the motion observed under the microscope. The sections behaved alike and the play of the joints was at once seen. I subsequently found that thin sections were not at all needed for this purpose, since the articulations may be perceived with the microscope in any fragment of the mineral. A piece is fastened to the stage, which is then inverted and slightly tapped to remove any loose grains of sand. Upon adjusting the instrument and touching the specimen gently with a quill point, it is perceived to be composed of small botrioidal masses or congeries of grains of sand. The observer can scarcely divest himself of the impression that he sees a loose layer of sand, until the stage is again inverted and jarred, which demonstrates that the grains are interlocked. By managing the reflected light, with which the object is illuminated, the plates of mica can be distinctly seen; they are very few in number and *take no part whatever in determining the motion.* The articulation is *not* that of basaltic columns. The component grains are arranged so that most of the groups have cavities and projections, and so that the projection of one group engages in the cavity of its neighbor.

By observing the thin edge of the specimen regular cavities are seen, out of which groups of sand particles have fallen. The rock may even be dissected by the needle point and shown to be made up of such congeries, and the groups may also be resolved into their constituent grains.

The millimetric length and breadth of the groups varies from $0{\cdot}26 \times 0{\cdot}26$ to $0{\cdot}26 \times 0{\cdot}32$, and the size of the individual grains composing the groups averages between $(0{\cdot}026)^2$ to $(0{\cdot}04)^2$ mm. Many are as large as $(0{\cdot}08)^2$ and some as small as $(0{\cdot}013)^2$. The general cubic capacity of a group or grain could be determined by multiplying the above areas by one of the linear dimensions given.

Each group appears to be composed of from 20 to 50 grains of sand not very strongly agglutinated. The individual grains are very "sharp" fragments of silica, not flat plates, and of great uniformity with respect to size.

The scales of mica are flat and nearly square fragments. They average in area $(0{\cdot}08)^2$ mm. and vary from $(0{\cdot}26)^2$ to $(0{\cdot}065)^2$ mm.

The Brazil mineral presents almost exactly the same character under the microscope as that from North Carolina, with the exception that the individual grains, as well as the congeries, are somewhat larger in the former. The oxyd of iron in the mineral is not the *cement* by which the grains are united, for a thin section of the rock boiled in HCl for five hours did not become more friable. The cement would appear rather to be siliceous (hydrated silica); because a piece boiled in a solution of caustic soda becomes partially disintegrated, especially at the edges, and is much more friable as to its mass.

When dilute solution of hydrofluoric acid is poured upon a thin section it is immediately resolved into grains, affording a complete disintegration of the section.

The flexibility of the itacolumite (N. C.) is shown in a striking manner with a cylindrical piece sawed out from a thick slab of the sandstone and rubbed down upon another piece to the required shape. The planes of stratification were taken parallel with the cylinder's axis.

The specimen measures 198 mm. ($7\frac{3}{4}$ in.) by 13 mm. ($\frac{1}{2}$ in.) in diameter. It can be compressed and elongated in the direction of its axis, the extent of the motion being a little over $\frac{1}{2}$ mm. When one end is fixed, the other end may describe a circle of 34 mm. ($1\frac{3}{8}$ in.) diameter, and may be made to touch every point in the area of the approximate spherical zone. The rod can also be twisted about its axis, the torsion being 10°.

Catenary.—When the rod is supported upon two nails 185 mm. apart, it assumes the form of a curve very like the catenary. The greatest deflection from the line joining the points of support varies from 3 to $3\frac{1}{2}$ mm. as the rod is rotated about its axis on the nails. My colleague and Prof. of Mathematics in the University, Col. E. W. Morgan, very kindly undertook the discussion of this curve with the following results. The curve was traced upon paper with a pencil under the stone resting upon two points of support at its extremities and the ordinates were measured for comparison with the ordinates of different curves.

Prof. Morgan at first compared with the circle, as the curvature was so slight, but it departed sensibly from that curve in such a manner as a true catenary would do. He then compared it with a loaded catenary (which is a parabola) with similar results. The beam loaded with equidistant equal weights (ellipse) was next essayed but the curve did not agree with it. Nor did it coincide with the true catenary. It was nearer to the loaded catenary than to any known curve. The result therefore of the calculation indicated that the curve of the stone lay between the catenary and the ellipse.

Prof. Morgan next prepared an experiment with a small beam of white pine loaded with equal equidistant weights for the ellipse, with a fine and flexible gold chain for the catenary, and with the stone cylinder. These were placed upon the same supports (185 mm. apart) and so arranged that the greatest deflection for each curve should be to the same point.

Upon comparing the chain with the loaded beam it was evident that the latter curve was a true ellipse, and consequently the comparison would be attended with no uncertainty due to a supposed defect in the slip of pine. The chain and stone were compared next, and then the stone and beam. Although the experiment was not of a character to afford very delicate measurements, it showed with great clearness that the curve of the stone is very nearly a catenary, and that it lies between this curve and the ellipse.

This result which was not anticipated by either of us, for we expected that the curve would prove to be a catenary, is very interesting and agrees with the jointed condition of the stone, as well as with the character of the joints shown by the microscope.

In a flexed beam the forces are partly compressive and partly tensile, as we consider the upper or the lower portions of the beam, and when the beam is loaded with equidistant equal weights, the conflict of these forces causes the beam to assume the form of the ellipse. The itacolumite cylinder takes the catenary form by reason of its ball and socket joints. But the rod has a definite thickness and a *series* of joints parallel with its axis, in this respect unlike a true chain. Furthermore, as the microscope shows, the sockets are *rough*, as they are formed by grains of sand, and the protuberances fitting into them are also rough. Consequently, when the stone bends by its weight between the supports there is a compressive action toward the top, and a tensile one along the bottom of the cylinder, as in the case of a beam, and this gives an elliptical character to the curve. As the diameter of the rod increased or diminished, I should expect to find the curve of the stone approach the ellipse or the true catenary.

The relation of itacolumite to the diamond.—The most interesting relation of this rock is to the diamond which it accompanies. This gem, found at first in the "gurgulho" or disintegrated rock, has at length been discovered *in situ* in the itacolumite itself; thus showing that this sandstone is at least one of the sources of the diamond.

The physical conditions which have led to the peculiar jointed character of the itacolumite may have had an important bearing upon the crystallization of the diamond, and hence it is of interest to ascertain what those conditions were, with the hope of throwing light upon the origin of the gem.

I confess to be at a loss to offer a very reasonable hypothesis with respect to these conditions. It is difficult to see why the siliceous fragments cohere to form definite groups or congeries. If we suppose that planes having a certain relation to the crystalline axes cohere by long continued contact more readily than planes having a different relation, why does this partial cohesion occur with such surprising regularity; why also is it not perceived in other sandstones? It would appear that the sand which formed this rock contained something diffused in a regular manner (and which was subsequently removed), which prevented the uniform contact of the siliceous grains. It is possible to conceive that *petroleum* might have that effect when added to sand of a certain degree of moistness, forming a kind of emulsion, and that the petroleum was afterward slowly removed by a process which permitted a crystallization of a portion of its carbon. When water was dropped upon dry sand, the mixture when stirred, formed lumps of uniform size; if, before stirring, a little petroleum was added, the lumps appeared to form more readily. The lumps are left out of aqueous contact by the coating of petroleum around each one, while the siliceous particles forming the lumps have water between their component grains. Cohesion could take place between the particles, but not between the lumps. Under the microscope the sand thus treated bears a striking resemblance to itacolumite.

I made this supposition before acquaintance with DeChancourtois's hypothesis that the diamond may have been formed from hydrocarbons, and that its origin is thus connected with the existence of petroleum-bearing schists. My hypothesis therefore receives a certain support from the views of DeChancourtois.

I have heated several of my specimens of itacolumite to ascertain whether any petroleum odor was evolved, but with negative results. If the diamond proceeded from a slow and gradual oxydation of the hydrocarbon perhaps we should not expect to find any petroleum left.

In this connection the small and rarely occurring black specks, seen with the microscope, are to be noted; are they minute black diamonds, and have they any relation to the experiment where the agate mortar was so deeply scratched?

Bethlehem, Pennsylvania, April 6.

ART. VIII.—*On the Laws which govern the general distribution of Heat over the Earth;*[*] *and on Brewster's Neutral Point;* by PLINY EARLE CHASE.

1. *The laws which govern the distribution of heat.*

THE principal elements of general thermometric variation are: 1, the heat imparted by the sun; 2, terrestrial absorption and radiation; 3, atmospheric currents. Of these three agencies, the first is, in one sense at least, the chief, since it is the one on which the others depend; the second is mainly instrumental in modifying the other two, and especially in retarding the daily and yearly changes; the third is a subject of hourly experience, and its meteorological importance is now generally recognized.

The amount of heat which is received directly from the sun, evidently varies as the cosine of the zenith distance, or the sine of the sun's altitude. In the daily distribution of temperature this is the most important element, as is evident from the tabular comparisons in my communication of Sept. 21, 1866.[†] Absorption and radiation proceed at nearly uniform rates, therefore it may be assumed that their effects are approximately proportional to the time during which they operate. The average general variation which is due to the influence of the winds is a difficult point to determine, but the present investigation has led me to believe that it may be measured by the difference of *arc* (instead of the *sine*-difference) of the sun's meridian altitude. My reasons for this inference are the following: 1, the general average temperature of the year often appears to vary very nearly as the arc in question; 2, it seems unreasonable to suppose that a variation of this character can be attributable either to the heat communicated by the sun or to terrestrial absorption and radiation; 3, the tendency of the air, so far as it is deter-

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[*] Abridged from the Proceedings of the Am. Philosophical Society, Feb. 1, 1867.

[†] Proc. Amer. Phil. Soc., vol. x, pp. 261–269. See, especially, the observations at St. Bernard, and the general average of Table I, p. 267.

mined by the direct heat of the sun, is at all times toward that point of the earth's surface at which the sun is vertical, and we may readily believe that that tendency should be proportional to the distance, measured on a great circle of the earth, through which the air would be obliged to move in order to reach the sub-solar point. This distance evidently varies as the *arc* of the sun's zenith-distance.

We have, then, three natural standards for admeasurement, by means of which, if we rightly eliminate special and limited perturbations, we may perhaps be able to determine the predominating influence, in many cases both of local and of general thermal disturbance. In order to institute as broad a comparison as possible, I have adopted a method of elimination which may be illustrated by a single example.

The average monthly temperatures of the United States, as deduced from Prof. Coffin's reductions, appear to be as follows:

Jan. 28·352	Feb. 30·873	Mar. 39·049	Apr. 49·744	May 60·902	June 69·780
July 75·640	Aug. 71·754	Sept. 65·643	Oct. 53·922	Nov. 42·350	Dec. 32·132

Averaging the temperature at equal intervals from January (taking the mean temperature of Dec. and Feb., of Nov. and March, &c.), we get the following results.

Months from Jan.	0	1	2	3	4	5	6
Average temp.	28·352	31·502	40·699	51·833	63·272	70·767	75·640
Monthly diff.	....	3·150	12·347	23·481	34·920	42·425	47·288
Ratio of do.	....	·067	·261	·497	·738	·897	1·000
Ratio of diff. of zenith distance,	....	·069	·255	·500	·745	·931	1·000

The second of the above series of ratios (that of the differences in the arcs of the sun's zenith-distance) is based upon the following estimate of the average monthly increase of solar altitude at all places in the temperate zones.

Mos. from winter solstice,	1	2	3	4	5	6
Increase of solar altitude,	3¼°	12°	23½°	35°	43¾°	47°
Ratio of increase,	·069	·255	·500	·745	·931	1·000

If we allow about 24 days for the cumulative effects of increasing heat and cold, these ratios become properly comparable with the monthly ratios of temperature-variation, as in the following table, which is compiled from the works of Dove and Guyot.

Diff. of time, mos.	1	2	3	4	5	6
Ratios of sines,	·076	·284	·545	·784	·946	1·
" " arcs,	·069	·255	·500	·745	·931	1·
N. Hemisphere,	·076	·259	·512	·753	·935	1·
S. Hemisphere,	·077	·281	·538	·763	·938	1·
Arctic region,	·071	·231	·479	·733	·934	1·
Europe,	·069	·239	·501	·738	·938	1·
Asia,	·097	·274	·535	·769	·934	1·
N. America,	·055	·279	·494	·741	·917	1·
S. America,	·077	·275	·501	·724	·936	1·
Africa,	·088	·267	·537	·761	·938	1·
Australia,	·081	·313	·618	·801	·913	1·

An extensive series of comparisons* seems to warrant the following inferences, all of which are confirmed by other considerations.

1. Taking into view the entire land surface of the globe and the entire range of the year, the direct heat of the sun and the induced aerial currents appear to be about equally instrumental in determining fluctuations of temperature.

2. The influence of the winds is most marked in the Northern and Western hemispheres; that of solar obliquity, in the Southern and Eastern hemispheres.

3. Where the sun's rays are least intense (as in the Polar Regions) and where the winds are most variable, the ratios exhibit the nearest parallelism to the increments of arc; but where the winds are most uniform (in and near the region of monsoons), they correspond more closely with the sinal increments.

4. The general changes of temperature at midwinter, and at the equinoctial seasons (when the sun's declination is changing most rapidly), are most dependent upon the local solar heat; the midsummer changes are more subject to the influence of the winds.

5. The greatest conflict of opposing forces occurs during the sun's passage between the comparatively wind-governed Northern hemisphere and the sun-governed Southern hemisphere. This conflict is manifested in the spring and autumn rains.

6. The closest and most general approximation of ratios is shown in the monthly temperature change at midsummer, which corresponds almost precisely with the change of arc.

2. *On Brewster's Neutral Point.*

In the April number of the Philosophical Magazine, Sir David Brewster says: "Dr. Rubenson has never been able to see, even under the fine sky of Italy, the neutral point which I discovered under the sun, and which, I believe, has never been seen by any other observer than Mr. Babinet."

The point is question can be easily seen in Philadelphia on any clear day, when the sun is more than 20° above the horizon, and I have reason to believe that it can be found with equal ease at many other places in the United States, although I have not been able to find any published observations except my own.†

As all the phenomena of skylight polarization are very interesting, and as some of its laws are still imperfectly understood, others may, perhaps, be induced to turn their attention in this direction, so as to determine whether the difficulty experienced by European observers is owing to a higher latitude, to a moister atmosphere, or to some other cause.

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* See Proceedings, &c., loc. cit.

† Proc. Amer. Phil. Soc., vol. x; this Journal, vol. xlii, pp. 111, 112.

A simple Savart polariscope is sufficient for making the observations. In positing Brewster's neutral point, I have usually raised the lower sash of an attic window so that the bottom of the sash will screen the sun from the polariscope. I have thus been able, in every instance when the atmospheric conditions seemed favorable, to see very distinctly the neutral point, and the oppositely polarized bands above and below.

ART. IX.—*Contributions toward a Theory of Photo-chemistry;* by M. CAREY LEA.

IN a somewhat extended series of experiments published at various times,[*] I endeavored to fix, as far as I was able, some of the facts of photo-chemistry, and more especially the nature of the action of light upon iodid of silver, at once the most important and the most difficult of explanation of all the facts of photo-chemistry which fall under our notice. The phenomena exhibited by iodid of silver, in the point of view which they assume to me, are the key to the whole matter, and based upon them, I propose to offer some theoretical views upon the general subject.

The study of light has always been largely aided by analogical reasoning from another source—that of sound, whose phenomena probably afforded the first conception of the undulatory theory, and in turn, discoveries made in light have aided our knowledge of the phenomena of heat, many of which would perhaps have been still unknown but for the aid so obtained. It is therefore perfectly allowable to reason analogically back from heat to light.

The tendency of heat is always to equalize itself, by radiation and conduction. The loss of heat in this way where the body affected is much above the temperature of those that surround it is enormously rapid, and this loss continues with diminishing rapidity till an equilibrium is attained.

The same is the case with light, though the loss is there usually so much more rapid as to be almost simultaneous with the reception, to our senses, and in the ordinary conditions of observation it is quite so. But the exceptions are perfectly well marked. The phenomena of *phosphorescence* show that a body may retain the impression of light for a considerable time. And the phenomena of phosphorescence received an immense extension from the ingenious and beautiful experiments of Becquerel,

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[*] A brief résumé of many of these experiments was published in this Journal in the year 1866.

who showed that a very large number of bodies continued to emit light for an appreciable time after the direct influence of light ceased to operate upon them. Although the time might be but a very small fraction of a second, still it was rendered brilliantly evident to the sense, and the exact period could be measured. And when we consider the enormous rapidity with which the phenomena of light take place, even the fraction of a second is a long time, and it would be exceedingly rash to attempt to limit such phenomena to our powers of observation.

Just as with heat there exists in all probability an absolute zero at which heat-vibrations cease, so probably there is a light zero at which the body ceases to vibrate luminously. Most bodies (to our perception) reach this zero immediately when carried into darkness. Phosphorescent bodies, form, however, a striking exception.

Let us suppose that a body be surrounded by other bodies equally illuminated, and that temporarily an additional quantity of light falls upon it. On the cessation of this illumination, the body will recover its condition of equilibrium with surrounding bodies, by losing its excess of light in the following manner: 1. By reflection. 2. By transmission. 3. By conversion into heat. 4. By chemical action. 5. By radiation.

That is, the body, if it be transparent, or have reflecting surfaces, will part with a certain quantity of its light in those ways. If it is susceptible of chemical decomposition, a certain portion of light will be consumed in effecting that decomposition. And what farther loss is necessary to take place in order to reach an equilibrium, must take place by conversion into heat and by radiation. As we have already seen, this radiation may be either instantaneous, as in the case of most bodies, or it may require minutes, hours, or even days, as in the case of phosphorescent bodies. This fact is of the utmost importance in the attempt I here make to explain the phenomena of photo-chemistry.

In their influence upon combustion and decomposition, the phenomena of light and heat exhibit a striking parallelism. Each tends in some cases, to promote combination, but in the vast majority of cases, to dissociate elements already combined. Such especially is the action of light in the cases which I propose to consider.

I have shown elsewhere, that, contrary to long-established opinion, perfectly pure iodid of silver, isolated from all other substances, is sensitive to light, and this fact, now I believe universally admitted, must form the corner-stone of photo-chemistry. For iodid of silver is precisely the only substance fitted to give us a clear view into the action of light upon matter in general, by which I mean that this action is so much more evident and appreciable in the case of iodid of silver, that we may thence obtain views subsequently to receive a wide extension.

Now when pure iodid of silver is exposed to light, it changes slightly in color, and has acquired a new property, that of attracting to itself a metallic precipitate in the act of forming, or a metallic vapor already formed. Some have seen in this action of light upon the iodid, a distinct reduction to sub-iodid. But of this, proof is altogether wanting. An extension of the exposure many million fold does not produce a reduction appreciable by the most delicate reagents, and I have been enabled to prove that such iodid perfectly recovers its sensibility in the dark. That is, a film of such iodid, exposed for many hours to a bright sun does not further darken beyond the change produced by the first instants of diffuse light. And if then put aside in the dark for a brief time it re-acquires the capacity by exposure for a second, to receive an image.

But if, during this exposure, or subsequent to it, a body capable of combining with iodine be brought into contact with it, a true chemical decomposition takes place. The silver loses half of its iodine, is reduced to sub-iodid, and a vapor, or a precipitate, under favorable circumstances, is attracted to the parts so acted upon.

What then is the nature of this change, this impression, received in a second, and then slowly passing spontaneously away? Evidently a physical, not a chemical change, though leading the way to a chemical change. But what is that physical change?

When light falls upon a compound body, its molecules are made to vibrate, and if that vibration be carried to a certain violence, the excursions of its atoms may exceed the limit which their affinity permits, and the compound will be torn asunder. We have an exact analogue of this in sound. A thin glass vessel, if a certain note be sounded near it with sufficient force, will be shattered, the excursion of its atoms exceeding the limits imposed by its attraction of cohesion. Vessels of other materials would resist this and much greater strain. Just so with light. Some bodies will be decomposed, others will resist. So when pure *chlorid of silver* is exposed to the light, it presently assumes a violet color, losing at the same time one-half of its chlorine. On the other hand, when pure *iodid of silver* isolated, is exposed to light, no chemical change takes place. But the impression of light is for a time persistent. Now the analogy which exists between this effect and phosphorescence has not been before perceived. *The "physical" impression of light is a persistence of the invisible* (*or "chemical"*) *rays exactly parallel to the persistence of visible or luminous rays, in phosphorescence.* The vibrations excited by light are in both cases not given out instantaneously as in most light-phenomena that pass under our notice, where the return to photo-equilibrium is immediate, but this equilibrium is only reached after the interval of hours or days.

Consequently, so long as these vibrations of non-luminous light (so to speak) continue, the body under their influence is much more exposed to suffer decomposition than when under normal influences. And if a film of such material has had parts exposed to light while other parts have been protected, and the whole be then exposed to influences provocative of decomposition, it is evident that those influences may be so graduated that they will tell only upon the parts predisposed by the impression they have received.

This function of light which I here endeavor to prove the existence of, may be conveniently termed *Actinescence.*

That this word does not express with entire accuracy what is intended to be conveyed, is sufficiently evident. But it has the advantage of connecting the phenomena with the parallel one of phosphorescence, and is perhaps on the whole as well suited as any other that could be found or made.

Where, through phosphorescence, a body temporarily retains, and subsequently emits light, that emission, in the gradual return to its photo-equilibrium, is rendered evident by the phenomena that usually accompany the emission of light. Surrounding objects are illuminated, faintly but visibly. Should we not therefore expect similar results in the case of actinescence?

Not only should we find them, but they have actually been described, though not understood. For in actinescence we have the explanation of the phenomena described by Niepce de St. Victor as the "storing up of light" (emmagasinement de la lumière). St. Victor showed that certain objects exposed to light and then carried into darkness had in some cases acquired the power of acting chemically upon other bodies with which they were placed in contact. His results were received at first with something like derision, and the facts, which could not be denied, were said to arise from some chemical decomposition which had taken place in the body during its exposure to light, generating reducing agents which were subsequently given off in the darkness.

But until now, the identity between the latent physical image and the storing up of light has not even been guessed at, still less the perfect parallelism between these phenomena and that of phosphorescence. That a body may immediately regain its equilibrium with respect to one sort of rays and slowly with respect to another, involves no difficulty whatever; we continually see this in the facts of common phosphorescence. Different phosphorescent bodies emit light of different colors. If one phosphorescent body emits a red, another a green, another a blue light, there is evidently no difficulty in conceiving that in others, the tendency to a slow recovery of equilibrium may belong to the still more refrangible and invisible rays of the spectrum. In fact this is so completely within the analogy of the subject that it would be surprising if it were not the case.

Viewed in this manner, the physical impression of light, as distinguished from the chemical, loses all its difficulty and mystery. A substance like iodid of silver is capable of decomposition by light, only when in contact with some substance having an affinity for iodine. But if exposed in an isolated condition, it becomes *actinescent*, it retains the disturbance occasioned by the light, and only gradually parts with that energy to surrounding objects. So long as any portion of this impression lasts, it is capable of undergoing decomposition if brought into contact with substances capable of taking up iodine from it.

Iodid of silver when exposed to light in a state of perfect purity and isolated from all other substances, undergoes no chemical change. Carried into darkness, it continues to vibrate in unison with the more highly refrangible rays, either those entirely beyond the visible spectrum, or else those having a very low illuminating power, and this in so faint a degree that no phosphorescence is visible. If it now be brought into contact with any substance which would have occasioned decomposition in presence of light, then, so long as this phosphorescence of actinic rays, this *actinescence* continues, the same decomposition will take place. If simply left in darkness, this actinescence will, as I have already shown, gradually expend itself, precisely like ordinary phosphorescence. And also as in the case of ordinary phosphorescence, a fresh exposure to light will create a fresh impression, the iodid of silver having apparently perfectly recovered its original condition. With perfectly pure iodid of silver, twenty-four hours is sufficient to nearly obliterate the action of light, the actinescent power is exhausted, or nearly so, and the iodid can be exposed again. If this second exposure be made under a photographic negative, and an ordinary photographic developer is applied, a clear sharp image is obtained.

It seems worthy of remark that though no visible phosphorescence is noticeable in the case of iodid of silver, it is by no means impossible that if examined by the ingenious instrument constructed for Mr. Becquerel by Mr. Dubosc, a visible phosphorescence might also be observed. However this may be, it does not affect the principles here laid down.

The general views here expressed will be found to throw light upon other obscure photo-chemical phenomena besides the latent physical image. Of these I shall briefly cite one.

If light fall upon a body decomposable by light, its energy will be expended in two directions. Part will be transmitted to surrounding objects, part will be expended in dissociating one or more of the elements of the body. As the intensity of the light increases, the amplitude of the excursions also increases, and a larger proportion will be expended in decomposition. It therefore follows that the decomposition effected will not be in the ratio of the intensity of the light, but will be greater in a strong light and less in a weak; that is, that a light of half strength acting for a double time, will not effect an equal amount of decomposition. Now this exactly accords with the universal experience of photographers who find that where media of unequal thickness are interposed between a sensitive surface and the light, as in the case of a negative superimposed upon chlorid of silver, the weaker the light the greater will be the contrast in the degrees of effect produced upon the different parts of the film; so much so that this is systematically adopted as a base of operation.

To enlarge farther here on the application of these principles, and the light they throw upon photographic phenomena, would, however, be inconsistent with the limits I have imposed upon myself. My object here has been to prove the existence of a well-marked but hitherto overlooked property of matter, and further to show the identity of this property with what in photo-chemistry has been vaguely described as the physical image.

This explanation of these obscure phenomena seems so simple and sufficient as scarcely to require proof. Nevertheless that proof is afforded by the reactions of iodid of silver, perhaps the most remarkable substance with which chemistry makes us acquainted. This theory rests upon two properties for whose existence I have long contended, and which I believe I have succeeded in establishing, namely, the *sensitiveness to light of iodid of silver even when perfectly isolated*, and its *spontaneous recovery of that sensitiveness* after obliteration through powerful action of light, by simply remaining in darkness. From these facts I deduce the conclusion that the latent image is simply due to a phosphorescence of chemical or actinic rays to which property I give the name of actinescence.

ART. IX.—*Contribution to the Chemistry of Brines;* by CHARLES A. GOESSMANN, Ph.D.

ALL natural solutions of chlorid of sodium, which are used for the manufacture of salt, are more or less contaminated by various saline admixtures. The peculiar influence exerted by certain of these foreign compounds on the chemical composition, the form, and the general external appearance of the chlorid of sodium, during its separation as a commercial article, even under the same system of manufacture and with the same precautions, has occupied the attention of chemists from the earliest times in the history of this branch of chemical industry.

A classification of brines, for the purpose of aiding their investigation, had in the course of events become advisable; and among others, Karsten* at an early date, made some advances in this direction. In his valuable discussions upon brines he has adopted the following principle; the brines are divided into two classes; the *first* class includes all brines containing *chlorid of magnesium* and *sulphates;* and the *second* class those containing *chlorid of calcium* beside *chlorid of magnesium.*

He favored at that time, the volcanic theory, in regard to the origin of the rock salt (primitive deposits), a view long since discarded as a general rule, in favor of its marine origin. He considered it self-evident, that the brines, in every well investigated case could be proved to originate from the dissolving action of an underground fresh water current upon rock salt. Their differences in composition were ascribed,—leaving the concentration as to amount of salt dissolved entirely out of the question,—in regard both to quantity and to quality, to the peculiar nature and condition of the strata, which had intercepted their passage to the surface. According to his view, decaying pyrites, sulphates and chlorids of the metals and earths were the main cause of the contamination of these solutions of rock salt. The extent to which these compounds happened to be met with, decided ultimately the amount of foreign admixtures thus imparted, while their final quality and relative proportion was determined by the order of succession in which the contaminated brines chanced to traverse limestone rocks or dolomites. The gypsum present was considered in most cases to be the result of the reaction of soluble sulphates—particularly of the alkalies, of magnesia or of iron, upon chlorid of calcium; moreover, primary and secondary deposits of chlorid of sodium were admitted. The presence of chlorid of calcium consequently was looked upon as merely accidental, no certain relation as to its connection with a particular geological age, being presumed. Subsequent

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* C. J. Karsten, Salinenkunde, vol. i, p. 220. Berlin, 1847.

investigations gave more importance to the presence or absence of this compound; and its presence has since been recognized as especially characteristic of the salt deposits of ante-tertiary date. Consequently these have been considered as a product of the constant admixture of the oceanic waters of preceding geological periods; while on the other hand its absence in our present ocean and in most salt deposits of a more recent date, is an established fact. Although the results obtained by numerous investigations are such as scarcely to admit of a doubt, that changes in regard to the chemical composition of the oceanic waters have taken place in the course of time, and are still in progress, we must acknowledge, that our ideas concerning the main features of the primitive or silurian oceans are still vague, and especially so upon this one point.

As mineral waters and brines issuing from Silurian rocks are at present the only sources from which we can draw information, our conclusions must partake of a more or less arbitrary character; for both these saline solutions may be due to a percolation of fresh water through Silurian rocks impregnated with the *entire* saline matter of the concentrated or evaporated marine waters of a preceding, a contemporary, or a succeeding geological period; or, they may be due to a re-solution of portions of such deposits, or to a mere oozing out of their mother-liquors in in a more or less diluted condition. The difficulties in establishing even approximately their original composition are increased when we contemplate the possible changes which the original saline mass may have suffered in the course of time[*] in consequence of mechanical and chemical influences and subsequent alterations of its partial solutions in passing to the surface. Yet as long as the discovery of a well preserved marine evaporation of undeniable Silurian origin does not furnish us with a fitter material to study, we have to make the best of the means at hand; for it cannot be denied, that much interesting and useful information bearing upon general principles in chemistry and geology has been and may hereafter be drawn from the study of the saline solutions, mineral waters and brines of decided Silurian origin, i. e., issuing from Silurian rocks. The Silurian rocks of the State of New York abound with saline springs and mineral waters of various kinds;[†] the same fact is known in Canada. T. S. Hunt has recently illustrated[‡] by analytical statements, the relation which various kinds of mineral waters, mainly from Canada, bear toward each other; his arguments tend to prove, that the various classes of Canadian waters

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[*] An examination of the rock salt deposit at Stassfurt, Germany, shows that the whole deposit suffered at a later date from influences which, among other results, caused the formation of Tachhydrite ($=CaCl+2MgCl+12HO$—Rammelsberg, etc.) —F. Bischof, Steinsalzwerke bei Stassfurt. Berlin, 1864, pp. 33–34.

[†] See Geology of State of New York, etc.

[‡] This Journal, March, July, September, 1865.

referred to in his essay can be considered as originating from one and the same primal source; and that they have changed in consequence of the peculiar kind and condition of the rocks with which they came in contact. The changes themselves appear to be more considerable where disturbances and molecular changes within the sedimentary rocks have favored disintegration.

The main reaction upon these saline waters is ascribed to alkaline solutions, resulting from decaying feldspathic rocks, soluble silicates and particularly carbonate of soda.[*] The differences which are observable in these waters in regard to the relative proportions of chlorid of sodium and the admixtures of alkaline earths whilst passing through the various stages of alteration, are explained by the fact, that the alkaline earths, lime and magnesia, are gradually rendered less soluble and thus partly eliminated as sediments in consequence of the change from chlorids and sulphates into carbonates and silicates, and that finally the eliminated chlorid of calcium, and magnesium, reappear as an increased amount of chlorid of sodium.

In a previous publication[†] I described a series of experiments which had been instituted for the purpose of supporting the view entertained by myself in regard to the chemical composition of a certain class of mineral waters of Onondaga Co., N. Y., and their relations to the brines of Syracuse in particular. In the course of that discussion I stated that a sufficient amount of carbonate of magnesia added to these brines, displaced quite readily the chlorid of calcium by forming chlorid of magnesium and carbonate of lime, and produced finally, at the expense of the sulphate of lime, if exceeding the chlorid of calcium in chemical equivalents, sulphate of soda, chlorid of magnesium, and carbonate of lime, provided an excess of free carbonic acid was secured during the whole reaction. The mode of alteration in the chemical composition of these brines, then merely indicated, appeared to me of sufficient interest to merit some more detailed illustration, particularly for the following reasons.

The brines of Onondaga issue from rocks of the Upper Silurian age; they indicate with great probability, by their composition, concentration, and copiousness, a close connection with quite an extensive salt deposit[‡] of that age, and thus may represent, to a certain extent at least, the constitution of a quite prim-

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[*] Soluble silicates of potassa and soda, and carbonate of soda, etc., have been for years applied to accomplish similar alterations, for technical purposes.

[†] Contribution to the Chemistry of the Mineral Springs of Onondaga, N. Y.—Syracuse, Feb., 1866; and also this Journal, September and November, 1866.

[‡] The brine furnished for the manufacture of salt since 1797 may be set down as being equal to at least two hundred millions of bushels of salt (each 56 lbs.); nearly $\frac{3}{7}$ may be counted for the last ten years; counting one cubic foot of solid salt equal to 140–142 lbs., about 15·5 cub. ft. will make one heavy ton (2240 lbs.); the amount of salt therefore removed since 1797 from that locality is equal to five millions of heavy tons, or seventy-five to eighty millions cub. ft. of solid salt.

itive salt formation; consequently any investigation of their changes promised some chance of obtaining information concerning the nature and extent of the various causes assigned for the existing differences in the chemical composition of the oceanic waters and the saline deposits of earlier and recent date.

Taking this view I intend to treat, in the following pages, of some changes, which the brines in question and those of similar composition* may suffer in regard to their chemical composition, adopting the following order:

First, changes in consequence of concentration; second, changes due to an access of carbonate of magnesia in presence of free carbonic acid, concluding with some generalizations.

I. *Changes in composition due to concentration.*—The brines in question contain from 16 to 17 per cent of saline matter; they are clear, colorless, and highly charged with carbonic acid gas when they issue from the wells; exposed to air they soon become turbid, deposit a small amount of hydrated peroxyd of iron and after some time become clear again.

A separation of gypsum and, under certain conditions,† of carbonate of lime also takes place subsequently, first as an incrustation on the sides of the vessels, afterward, particularly toward the point of saturation, as a film of crystals, partly swimming upon the surface, partly floating about the bottom. No further visible changes, aside from the increasing separation of chlorid of sodium and gypsum, are noticeable for some time until the evaporation practically ceases.‡

The following analytical statements may convey some idea of the changes within the liquid during the process of concentration at ordinary temperatures.

	I.	II.	III.	IV.	V.
Sulphate of lime,	0·5772	0·4110	0·1146	0·0304	0·0264
Chlorid of calcium,	0·1533	0·2487	2·6959	7·3420	10·4690
Chlorid of magnesium,	0·1444	0·2343	2·7513	6·2926	10·5020
Chlorid of potassium,	0·0119	0·0194	0·8177	undet.	3·3769
Bromid of magnesium,	0·0024	0·0039	undet.	undet.	0·4485
Iodine, etc.,	traces	undet.	"	"	undet.
Carbonic acid,	undet.	"	"	"	"
Chlorid of sodium,	15·5317	25·7339	20·1006	10·0901	8·7441
Carb. of protox. of iron,	0·0044	undet.	undet.	undet.	undet.
Water,	83·5	73·3	73·4	....	....

The analytical examinations being designed merely to answer certain questions, were not, as a general rule, carried out farther than is directly stated.

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* Karsten's second class of brines. The principles on which Karsten has based his classification are still acceptable for practical purposes; yet chemists might prefer at the present day to reverse simply his orders, for there seems, according to our present information, but little doubt that the brines of his first class are more or less derivatives of his second class, i. e., of those containing chlorid of calcium.

† This Journal, II, xlii, 372, Nov. 1866.

‡ Farther details in regard to these questions are given in my paper "On the manufacture of Solar Salt, etc." Syracuse, Dec. 1863, page 17.

Analysis No. I is from the brine of a particular well at Syracuse, and represents that brine, as far as figures have been given, in its original composition; analysis No. II is obtained from that same brine after being brought simply to the point of saturation; analyses Nos. III, IV, V, are from mixtures of brines from different wells; they were collected at different stages of concentration and the subsequent separation of the crystallized chlorid of sodium, etc. The discrepancies in regard to the varying relative proportions of the chlorids of calcium and magnesium observable in the foregoing statements are due to some slight differences in the composition of the original material subjected to evaporation. I stated on a former occasion that within a certain limit these brines differ somewhat in regard to the relative proportions of the deliquescent chlorids; these differences, although most trifling from a practical point of view so far as the brines are concerned, appear quite conspicuous, when the mother-liquors (or bitterns) are compared. A liquid of the composition of No. V has practically ceased to evaporate in our section of the country; its volume is constantly fluctuating, being influenced by the season and the condition of the atmosphere.

A glance over the various analyses suffices to show, that a large amount of sulphate of lime ($\frac{1}{4}$) is rendered insoluble before the crystallization of chlorid of sodium begins, and that the deliquescent chlorids of calcium and magnesium in Nos. III, IV, V, have materially interfered with the solubility of both chlorid of sodium and sulphate of lime. A closer examination into the relative proportions of the principal components of the liquids Nos. I and V proves that at least more than one thousand parts of chlorid of sodium and more than forty parts of the sulphate of lime must have been separated from solution No. I before a residual liquid of the composition of No. V could be obtained. Testing the separated saline mass on the other hand, we notice the following facts, which are a true type of the recognized condition in natural saline deposits; the chlorid of sodium which crystallizes out of the solution No. I during a continued evaporation, being impregnated with the remaining mother-liquor, contains always more or less of the chlorids of calcium and magnesium, besides the whole amount of the sulphate of lime separated. The relative proportion in which these two chlorids may be retained within the separated chlorid of sodium, corresponds closely with that of the original brine, while the entire amount of both present in the crystalline mass, is governed by particular circumstances; slow evaporation and steadiness of temperature, for instance, by favoring well developed individual crystals, react most decidedly toward their exclusion. The sulphate of lime, on the other hand, varies in quantity in the different layers of crystals of chlorid of sodium, throughout its whole mass; in cases where the evaporation has been started with a brine like No. I above, it forms the basis of the whole saline deposit and gradually decreases in quantity toward the close of evaporation, or within the upper layers.

I deem it of some interest, and therefore call attention here to the great resemblance in chemical composition of the saline liquid, No. v above, and some of the mineral waters of Canada, as shown by T. S. Hunt's analyses, particularly No. 4.*

It will be noticed that the results of evaporation previously stated will serve as a strong argument in favor of the view advanced concerning the probable origin of that whole class of mineral waters, namely, that they originate from mother-liquors or bitterns of the saline residue of marine evaporations of the Silurian age. The essential difference in the instances alluded to is apparently merely one of concentration. The Upper Silurian rocks in our vicinity are similarly impregnated with these assumed mother-liquors (or re-solutions of the upper layers of salt deposits) as the Lower Silurian rocks around the north and northwestern shores of Lake Ontario are represented to be.† The similarity in composition between the saline waters from both localities‡ manifests itself even in the peculiar variations in the relative proportions of the most characteristic compounds, particularly the deliquescent chlorids of calcium and magnesium, as may be seen from the following analyses of waters taken from the vicinity of Syracuse.

One hundred parts contain—

	A.	B.	C.
Sulphate of lime, . . .	0·0058	0·0794	1·7000
Chlorid of calcium, . .	4·8200	6·1143	8·4800
Chlorid of magnesium, . .	0·9281	1·7844	0·7830
Chlorid of potassium, . .	undet.	undet.	0·3530
Chlorid of sodium, . .	15·2288	8·7263	9·2430
Carbonate of iron, etc., . .	traces	traces	undet.§
Water, ...	79·0	83·3	979·441
	100·0000	100·0000	1000·0000

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* This water is from the vicinity of the bay of Quinte; 1000 parts contain of

Chlorid of sodium, - - - - - - -	17·4000
" potassium, - - - - -	undet.
" calcium, - - - - - -	9·2050
" magnesium, - - - - -	9·4843
Bromid of sodium, - - - - - -	undet.
Sulphate of lime, - - - - - -	" etc.

Table I, waters of first class; this Journal, II, xl, 44, July, 1865.

† T. S. Hunt, (loc. cit.).

‡ The question in regard to their real source so far as particular geological epochs are concerned, is, we presume, in many cases still open to discussion.

§ The presence of this large amount of sulphate of lime, and of carbonates is apparently due to an admixture of drainage waters from surface percolation, which pass through gypseous shale and diluvial drift.

If such relations exist in regard to the natural saline bitterns of both localities, as the history of the liquid No. V suggests, we may be entitled to assume, considering the area of actual observation the existence of extensive salt deposits within the Silurian basin. To advance here opinions in regard to their particular origin in either case, would be of little value, so long as careful local examinations are still wanting; since marine evaporations or salt deposits may occur independently of each other, between the successive strata within the same basin;* and irregularities and ruptures in the level of the rocks, caused by physical and chemical reactions from within and without, are quite frequently observed in the vicinity of salt deposits. Moreover, inferences drawn merely from the level of the rocks and the depths of the borings without a previous careful tubing of the latter are not less unreliable, than the conclusions adduced from the differences of temperature between the mean temperature of the locality in question and that of the saline waters issuing from the springs or wells; for the common rule of drainage may be changed by fissures, etc., and causes which produce alterations of temperature in consequence of chemical reactions are never wanting in circumstances like those under consideration. The decided differences in regard to the relative proportion of the saline waters, No. I, p. 80, and A and B, p. 82, which occur within quite a limited territory will in all probability find a less acceptable explanation, in the opinion of many, by supposing a difference in the chemical character of intercepting strata, than by assuming either entirely different sources or independent local secondary influences, similar to those for instance at Stassfurt, aided by irregularities in the level of the rocks of the same geological period,† for the brines of Syracuse are characterized by their small percentage of deliquescent chlorids of nearly *corresponding* quantity and their proportion of sulphate of lime, marks of particular significance considering the surrounding conditions.

II. *Changes in composition due to the reaction of carbonate of magnesia upon chlorid of calcium and sulphate of lime in the presence of carbonic acid gas.*—On a previous occasion I described the mode of action and the conditions under which carbonate of magnesia would act upon chlorid of calcium and sulphate of lime, both in the presence and in the absence of chlorid of sodium; only the first case belongs to the present discussion. It remains here merely to illustrate more in detail such changes as

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* Two independent rock salt deposits, for instance, have been found in the Thuringian basin; one in the Permian rocks (Zechstein), the other in the Triassic rocks (Muschelkalk). (F. Bischof, Steinsalz werke bei Stassfurt. Berlin, 1864, p. 5.)

† At Stassfurt, a layer of magnesian compounds several hundred feet in thickness occurs above the rock salt, while at Schonbeck (belonging to the same deposit) this layer is wanting. (F. Bischof.)

have been before indicated. Our brines contain both chlorid of calcium and sulphate of lime, and are highly charged with free carbonic acid; they are thus liable to undergo alterations in both the directions mentioned.

The circumstances under which these two reactions take place leave it somewhat doubtful to which particular reaction the removal of the chlorid of calcium may be ascribed, whether to a mere substitution of the calcium of the chlorid of calcium by magnesium, or indirectly to the decomposition of the sulphate of lime into sulphate of soda, carbonate of lime and chlorid of magnesium; and the subsequent reaction of the sulphate of soda thus formed, upon the chlorid of calcium, reproducing thereby again sulphate of lime and chlorid of sodium, previously decomposed. Whatever the order or the extent of either of these two distinct and available modes of changing the composition of the brine may have been in this instance, a corresponding amount of chlorid of magnesium and of carbonate of lime are in either case the final products; and as carbonate of lime rapidly separates (settling), in the case of more saturated solutions, an addition of chlorid of magnesium* equivalent to the amount of chlorid of calcium removed, remains practically the only material acquisition of the brine. Quite different are the final results, so soon as the accessible carbonate of magnesia begins to exceed the chemical equivalent of the chlorid of calcium; for by the aid of free carbonic acid† the sulphate of lime will be decomposed and thus on account of the presence of chlorid of sodium, every additional amount of the carbonate of magnesia will produce a corresponding amount of sulphate of soda, chlorid of magnesium and carbonate of lime, which compounds remain intact; these changes may thus continue until all the sulphate of lime has been decomposed. The amount of sulphate of soda, etc., liable to be produced by the foregoing reaction, depends apparently entirely upon the supply of both, i. e., carbonate of magnesia and sulphate of lime.

To render these changes more striking I will illustrate them by numerical statements:

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* Attention has been called to the fact as being quite remarkable, that no brines containing chlorid of calcium without containing also chlorid of magnesium have been noticed; the reverse occurs as is well known quite frequently. Brines from the States east of the Mississippi containing no chlorid of calcium have not thus far come under my observation, while such brines seem to occur quite frequently in the States west of that river, as examinations of brines and salt from Nebraska, Kansas and Arkansas, etc., have proved to me; they also contain frequently considerable quantities of sulphate of soda, etc.

* The amount of carbonic acid noticeable in mineral waters when issuing from springs, or forced out from wells, gives rarely a correct idea of the amount at work, for their passage upward over rough surfaces, and their exposure to higher temperatures, etc., cause its partial liberation by escape through the soil, etc.

	A.	B.	C.	D.
Sulphate of lime,	0·5772	0·5772	0·2885	....
" of soda,	....	....	0·2900	0·5912
" of potassa,	....	....	0·0139	0·0139
Chlorid of calcium,	0·1533	....	....	....
" of magnesium,	0·1444	0·2756	0·4772	0·6786
" of potassium,	0·0119	0·0119	....	....
Bromid of magnesium,	0·0024	0·0024	0·0024	0·0024
Chlorid of sodium,	15·5317	15·5317	15.3028	15·0445
Water,	83·57	83·57	83·57	83·57
Carbonate of lime,	....	0·1381	0·3502	0·5625

A represents the brine with its original composition; B represents the same brine subjected to the action of but 0·1160 carbonate of magnesia dissolved in water containing carbonic acid gas; this amount of carbonate of magnesia is equivalent to the chlorid of calcium present; C represents the same brine after the reaction of 0·2943 carbonate of magnesia, causing besides the removal of chlorid of calcium also that of one half of the gypsum present; it changes chlorid of potassium into sulphate of potassa and leaves besides a corresponding excess of sulphate of soda. D represents the brine after the entire decomposition of the chlorid of calcium and the sulphate of lime; the latter is represented by sulphate of soda in solution, formed of course partly at the expense of the chlorid of sodium; 0·4725 neutral carbonate of magnesia, aided by carbonic acid gas, are required to cause such complete changes. The whole amount of lime as chlorid and sulphate in the original brine is changed into carbonate.

The carbonate of lime formed during each stage of progress has been noted separately; the largest proportion, in instances like those presented above, would settle soon after its formation, since the degree of its solubility in this case depends upon the concentration of the saline liquid, the temperature and the time of its formation, leaving the particular influence of the carbonic acid gas as a means of solution out of consideration.

Viewing these four statements from Karsten's standpoint we notice that while A belongs undoubtedly to his second class of brines, B, C and D, must be counted to those of the first class. Accepting on the other hand, the fact that such changes are going on in saline solutions in our Silurian rocks, we must concede that the saline matter of the Silurian ocean may even change within the Silurian rocks to such a degree as to resemble those of the present ocean; for, whatever essential compounds of the latter are not mentioned in the above statements, we must acknowledge can be constructed from their components present, making allowances for influences of temperature, and concentration, and for the peculiar view taken in regard to chemical affinity under both of these circumstances; the difference in the *relative proportions* of the *various compounds* depends on entirely different causes.

The particular conditions required to render such a change of the brine possible, are, it can scarcely be denied, abundantly supplied, particularly in consequence of the extensive exposure of our Silurian rocks. Chlorid of sodium has been and is still performing a most important part in the disintegration of a large number of rocks, by chemical and particularly by mechanical forces in consequence of its hygroscopic quality.

Chlorid of sodium and sulphate of lime are almost everywhere associated; they occur not only as more or less well defined deposits of varying extent, but they must originally have pervaded every sedimentary rock from the lowest Silurian to the latest marine formation. Subsequently they have found access to many formations of a later date and different origin by the ascent of percolating waters. Most of these rocks contain, more or less abundantly, compounds of magnesia, particularly carbonates,* and have thus uninterruptedly yielded quantities of that substance to solutions, wherever such powerful disintegrating agencies as change of temperature, access of moisture and free carbonic acid have been at work; the destruction of these rocks is a mere matter of time. Many sedimentary rocks may have been exposed to these influences temporarily, perhaps in a less indurated state, and consequently have presented conditions most favorable for transformation and subsequent extraction; circumstances which may sometimes account for the total or partial abstraction of sulphate of lime from a number of sedimentary rocks of marine origin.†

Relying here, more on the duration than on the intensity of the action, I believe that the final results of reactions like those considered in the foregoing discussion, must *in common with other causes*, have exerted an important bearing on the composition of the marine waters, during the development of our present surface-configuration; and they may in particular instances have assumed proportions sufficiently extensive to account even for more localized accumulations of sulphate of soda, in connection with

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* Researches of Ebelman, confirmed by T. S. Hunt, have proved that magnesia and lime are first abstracted, by means of carbonic acid, from even basaltic and similar rocks and that in the case of labradorite, the removal of these two alkaline earths was even more complete than that of the alkalies, (this Journal, II, xxxix, 181, March, 1865); a series of analyses of waters from along the N. Y. Central railroad by Dr. C. F. Chandler (New York, 1865), as well as some of my own analyses furnish a direct proof of the fact, that the carbonate of magnesia enters in an unusual proportion into the composition of a large number of our spring waters.

† Mineral waters issuing from rocks in the city of Oswego (gray sandstone) along the Oswego river contain large percentages of chlorid of sodium, besides the chlorids of magnesium and calcium; they are free from sulphate of lime. Analysis gives, in 1000 parts, $NaCl$ 5·622, $MgCl$ 0·140, $CaCl$ 0·3152, etc.

chlorid of sodium as well as with other saline compounds. The whole reaction of carbonate of magnesia, in the presence of carbonic acid gas, upon brines like ours, resembles somewhat, so far as some of the final results are concerned, that of carbonate of soda provided the latter does not exceed in chemical equivalents the chlorid of calcium and sulphate of lime present, sulphate of soda, and carbonate of lime being formed in both instances; they differ only in one essential point; in case of the addition of carbonate of soda the chlorid of calcium is simply eliminated (only traces of carbonate of magnesia being produced) and its place supplied by a corresponding amount of chlorid of sodium, while in the case of the addition of carbonate of magnesia the chlorid of calcium is replaced by a corresponding quantity of chlorid of magnesium. The following statement demonstrates the changes due to the addition of an amount of carbonate of magnesia or of carbonate of soda chemically equal to the amount of chlorid of calcium present, since, as soon as that point is passed both carbonates produce sulphates of soda, as long as sulphate of lime remains in excess.

	1.	2.	3.	4.
Sulphate of lime, . .	0·5772	0·5772	0·5772	0·7652
Chlorid of calcium, . .	0·1533	....	....	....
" magnesium, .	0·1444	0·2756	0·1444	0·1444
" potassium, . .	0·0119	0·0119	0·0119	0·0119
Bromid of magnesium, .	0·0024	0·0024	0·0024	0·0024
Chlorid of sodium, . .	15·5317	15·5317	15·6933	15·6933
Water, ...	83·57	83·57	83·40	84·10
Carbonate of lime, . .	....	0·1381	0·1381	....

1 represents the original brine; 2 represents this brine treated with the necessary amount of carbonate of magnesia; 3 represents this brine (1) treated with a corresponding amount of carbonate of soda; 4 represents the original brine simply treated with an additional amount of sulphate of soda. We can scarcely imagine the variety of brines and mineral waters which may result in the course of time from this or similar brines, under different geological conditions, particularly if we consider the consequences, which must result from a mere difference in concentration before or after such changes as we have discussed in these pages have been fully or partly accomplished.

Slim indeed are the chances of learning anything more definite about the original composition of the saline mass of the oceanic waters of the Silurian age from our mineral waters and brines; since the extensive exposure of our Silurian rocks renders them subject to important changes by disintegration, and causes them to react decidedly upon percolating saline solutions.

Syracuse, March 14, 1867.

ART. XI.—*Notice of a new Genus of fossil Sponges from the Lower Silurian;* by Prof. O. C. MARSH, of Yale College.

WITHIN the last few years several specimens of a remarkable fossil have been found in limestone of lower Silurian age in Franklin county, Kentucky. Although generally recognized as *Amorphozoa* by paleontologists who have seen them, and evidently new to science, no description of them appears to have been published hitherto, except a brief notice by Prof. D. D. Owen, who proposed for them the name of *Scyphia digitata.**

The Cabinet of Yale College contains a very perfect specimen of this fossil, recently obtained from Prof. Hovey of Wabash College; and the writer had previously an opportunity of examining, in the collection of Mr. Sydney S. Lyon, of Jeffersonville, Indiana, a large and fine specimen, the original from which casts have since been supplied to the Yale and other museums, by Prof. Ward of Rochester.

In general appearance, and nearly all important characters, these two specimens are very similar. The form is that of a short vase, or cup, with a row of arms extending outward and downward from the lateral surface. These arms are hollow, and open directly into the main or central cavity, which is apparently larger than in any other known sponge, recent or fossil.

The specimen in the Yale collection is about six inches in diameter, and three in height. It has nine arms of nearly equal size and length, all with openings at their extremities. The base has a small protuberance near the center, but no other indication of attachment. The other specimen has eleven arms, and is nearly eleven inches in diameter, by three and a half in height. Both specimens are externally silicified. The main orifice, or mouth, is oval in form, and in the smaller specimen is situated at the end of a short neck, about one and one-half inches above the bases of the arms.

As these specimens are without doubt generically distinct from any yet described, the name *Brachiospongia* is proposed for the genus they represent; and, since there is apparently more than one species included under the name *digitata*, the trivial designation of *Rœmerana* may be added, in honor of Prof. Ferdinand Rœmer, of Breslau University, whose investigations have thrown so much light upon paleozoic sponges. The specimen in the Yale Cabinet may be regarded as typical of this species. Should the form represented by the large specimen already noticed prove a distinct species, this may appropriately be named *Brachiospongia Lyonii*, from Mr. S. S. Lyon, the discoverer of these interesting fossils. A full description of these specimens, with illustrations, will appear in an early number of this Journal.

New Haven, Ct., May 25th, 1867.

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* Second Report on the Geology of Ky., p. 111.

ART. XII.—*Crystallogenic and Crystallographic Contributions;* by JAMES D. DANA. No. IV,* *On a connection between Crystalline form and Chemical constitution, with some inferences therefrom.*

AMONG oxyds, the protoxyds, like the metallic elements, are characteristically *isometric*† in crystallization. The sesquioxyds are as characteristically *hexagonal*, this being the form of the sesquioxyds of iron, aluminum, and chromium. The deutoxyds are typically *tetragonal*, as seen in the deutoxyd of tin (tin ore) and of titanium (rutile and anatase). There are other forms among protoxyds, sesquioxyds and deutoxyds; for example, ZnO is hexagonal; TiO^2 in brookite, and MnO^2 in pyrolusite are orthorhombic; but these cases, as the following observations make apparent, may be regarded as a consequence of polymerism —a principle that has been recognized by others as underlying dimorphism.

Regarding the atom of oxygen as double in its fundamental

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* The preceding papers in this series by the writer are not numbered. They are: I, On the Formation of Compound or Twin crystals, vol. xxx, 275, 296, 1836; II, On certain laws of Cohesive Attraction (as illustrated by crystals); II, iv, 364, v, 100, 1847, 1848; III, On the Homœmorphism of mineral species of the trimetric [and other] systems, II, xviii, 35, 131, 1854, with the antecedent papers in xvii, 85, 210, 430.

† I propose to employ in the forthcoming edition of my Mineralogy the terms *Isometric*, *Tetragonal* (having a square base), and *Orthorhombic* (erect on a rhombic base), in place respectively of *Monometric*, *Dimetric*, and *Trimetric*. *Monometric* describes a line better than a cube; the hexagonal prism is as much *dimetric* as the square prism; and the oblique prisms are as truly *trimetric* as the right rhombic. It is very desirable that the technical terms of science should be uniform over the world, as far as possible, and that authors should be willing to yield their own usage for the sake of uniformity. The terms adopted appear to be the best that have been proposed, and have already extensive use in Europe. *Isometric* is Hausmann's term; *tetragonal* and *hexagonal*, with *rhombic*, are employed by Naumann. Mohs's terms *pyramidal* for the tetragonal system, and *prismatic* for the orthorhombic, are exceedingly bad, as there are pyramids among isometric, orthorhombic and hexagonal forms, as well as the tetragonal; and prisms in all the systems excepting the isometric.

There is additional reason, for our proposed change, in the natural relations of the systems of crystallization. For the similarity in the names *monometric*, *dimetric*, *trimetric* (the latter two the *monodimetrischen* and *trimetrischen* of Hausmann) implies a fundamental relation in the forms; while the true classification is as follows: (1) *Isometric*, including the isometric system, peculiar in the absence of double refraction or polarization; (2) *Isodiametric* (from ἴσος, *equal*, and *diameter*), including the tetragonal and hexagonal forms (alike named from the shape of the base), characterized by equal transverse axes or diameters, and uniaxial polarization; and (3) *Anisometric* (from ἄνισος, *unequal*, etc.), including the remaining systems, and distinct in having the axes or diameters all unequal, and biaxial polarization.

Monoclinic, *Diclinic*, *Triclinic* (from Naumann) I would retain, as they express admirably the relations of the systems. *Clinorhombic* is often used for the monoclinic system, and is well enough. But *clinorhomboidal* for the triclinic would not be desirable, as the French commonly use the word *rhomboidal* where others use rhombic; and the *diclinic* could have no corresponding name, unless it be *clinorectangular*, which would be very objectionable.

nature, the number of atoms of oxygen (or the negative element) in the protoxyds is 2; in the sesquioxyds 6, or a multiple of 3; in the deutoxyds 4.

It appears from a survey of all hexagonal and tetragonal compounds to be a general fact, that the number of atoms of the negative element is 3, or a multiple of 3, in the former; and 2, 4, or a multiple of 4, in the latter; and that, consequently, the hexagonal and tetragonal systems are based on these numbers, respectively, their symmetry being a consequence of it.

1. *Tetragonal species, and the number* 4.—Among *unisilicates*—the silicates which have the ratio 1 : 1 between the oxygen of the bases and silica (SiO^2), and the number of atoms of oxygen 4, or its multiple—tetragonal species are common; while none occur among the *bisilicates*, in which the ratio is 1 : 2, and the number of atoms of oxygen is 3, or its multiple. There are none also among the anhydrous carbonates, which likewise have the oxygen ratio 1 : 2. But among these bisilicates and carbonates there are examples of *hexagonal* species. The compounds $\dot{\mathrm{C}}\mathrm{a}\dddot{\mathrm{W}}$ (scheelite), $\dot{\mathrm{P}}\mathrm{b}\dddot{\mathrm{W}}$ (scheeletine), $\dot{\mathrm{P}}\mathrm{b}\dddot{\mathrm{M}}\mathrm{o}$ (wulfenite), $\dot{\mathrm{Y}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ (xenotime) are tetragonal, the last having 8 of oxygen (or 16 if doubled) and the others 4. Matlockite ($PbCl+PbO$) is tetragonal, while $PbI+2PbO$ is hexagonal, and $PbCl+2PbO$ is orthorhombic. Cerasine ($\mathrm{PbCl}+\dot{\mathrm{P}}\mathrm{b}\ddot{\mathrm{C}}$) is tetragonal; and the number of atoms of the negative elements, O, Cl, is 4. Hausmannite is tetragonal, and with the usual formula $\dot{\mathrm{M}}\mathrm{n}\dddot{\overline{\mathrm{M}}}\mathrm{n}$ has 4O. Yet the formula is better written $\dot{\mathrm{M}}\mathrm{n}^2\ddot{\mathrm{M}}\mathrm{n}$, for this corresponds with its close relation in form to the RO^2 or deutoxyd group, while $\dot{\mathrm{M}}\mathrm{n}\dddot{\overline{\mathrm{M}}}\mathrm{n}$ is a formula of the isometric spinel group. Similarly, the tetragonal species chalcopyrite has the formula $2(\overline{\mathrm{C}}\mathrm{u}, \mathrm{Fe})\mathrm{S}+\mathrm{FeS}^2$. Braunite, taking the most recent formula for it, that of Rammelsberg, $(Mn, Si)^2O^3$, is apparently an exception. Its composition, as Rammelsberg shows, corresponds to $3\dddot{\overline{\mathrm{M}}}\mathrm{n}+\dot{\mathrm{M}}\mathrm{n}+\ddot{\mathrm{S}}\mathrm{i}$, and this formula has 12O, which is a multiple of 3, and satisfies the principle under illustration. But the true arrangement of the constituents makes it not a sesquioxyd, as above, but a *deutoxyd* like hausmannite, which it approaches in its tetragonal form; for the formula may be $2\dot{\mathrm{M}}\mathrm{n}^2\ddot{\mathrm{M}}\mathrm{n}+\ddot{\mathrm{M}}\mathrm{n}\ddot{\mathrm{S}}\mathrm{i}$, which is equivalent to 2 of hausmannite and 1 of a silicate analogous to the tetragonal species zircon ($\mathrm{Zr}\ddot{\mathrm{S}}\mathrm{i}$).* The deutoxyd of manganese, MnO^2 (pyrolusite), is orthorhombic, and approximately isomorphous with orthorhombic TiO^2 (brookite), the former having for the angles of

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* Hausmannite approaches more closely the anatase form of TiO^2 than the rutile form, the angle between *O* and the plane made 1-*i* in anatase being 119° 22′, and *O* : 1 (which might as well be 1-*i*) in hausmannite being 121° 3′. Braunite is much nearer cassiterite, rutile, and zircon, the corresponding angles for *O* on a pyramidal plane in these four species being, respectively, 135° 26′, 136° 26′, 137° 40′, 137° 50′. Thus the anatase and rutile form of TiO^2 are severally represented by hausmannite and braunite.

the prism *I*, and the domes 1-ī, 1-ĭ, respectively, 93° 40′, 104° 22′, 107° 54′; and the latter for the corresponding angles 93° 16′, 96° 46′, 99° 50′. MnO^2 in the tetragonal state is unknown except when it is in combination with $2MnO$, as in hausmannite. The protoxyd of manganese, MnO, it may be remarked, is isometric, like MgO, it having been obtained artificially in octahedrons and cubo-octahedrons by Deville (C. R., liii).

Among artificial compounds, there are the following tetragonal species all conforming to the principle stated:

$KF+HF$; $\dot{\mathrm{Be}}\dddot{\mathrm{S}}+4aq$; $\dot{\mathrm{N}}\mathrm{i}\dddot{\mathrm{S}}+7aq$; $\dot{\mathrm{N}}\mathrm{i}\dddot{\mathrm{S}}+6aq$; $\dot{\mathrm{N}}\mathrm{i}\dddot{\mathrm{S}}\mathrm{e}+7aq$; $\dot{\mathrm{Z}}\mathrm{n}\dddot{\mathrm{S}}\mathrm{e}+7aq$;
$(\dot{\mathrm{K}},\dot{\bar{\mathrm{H}}})^3\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$; $(\dot{\mathrm{Am}},\dot{\bar{\mathrm{H}}})^3\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$; $(\dot{\mathrm{K}},\dot{\bar{\mathrm{H}}})^3\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{A}}}\mathrm{s}$; $(\dot{\mathrm{Am}},\dot{\bar{\mathrm{H}}})^3\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{A}}}\mathrm{s}$; $\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}+2aq$; $(\dot{\mathrm{Am}}+\dot{\bar{\mathrm{H}}})\dddot{\bar{\mathrm{B}}}^2+3aq$;
NaO, IO^7; $KCl+CuCl+2aq$; $AmCl+CuCl+2aq$; $\dot{\mathrm{A}}\mathrm{g}\dddot{\mathrm{S}}+2NH^3$, $\dot{\mathrm{A}}\mathrm{g}\dddot{\mathrm{C}}\mathrm{r}+2NH^3$,
$2\dot{\mathrm{K}}\bar{\mathrm{A}}\mathrm{c}$ (acetic acid)$+\dot{\mathrm{C}}\mathrm{u}\ddot{\mathrm{C}}+12aq$; $\dot{\mathrm{C}}\mathrm{a}\bar{\mathrm{A}}\mathrm{c}+\dot{\mathrm{C}}\mathrm{u}\bar{\mathrm{A}}\mathrm{c}+8aq$, $\dot{\mathrm{K}}\bar{\mathrm{A}}\mathrm{c}+2\dddot{\bar{\mathrm{U}}}\bar{\mathrm{A}}\mathrm{c}+2aq$, $\dot{\mathrm{A}}\mathrm{g}\bar{\mathrm{A}}\mathrm{c}+$
$2\dddot{\bar{\mathrm{U}}}\bar{\mathrm{A}}\mathrm{c}+2aq$; $(\frac{1}{3}\dot{\mathrm{C}}\mathrm{a}+\frac{2}{3}\dot{\bar{\mathrm{H}}})^3\bar{\mathrm{T}}$ (tartaric acid, containing 5O)$+\dddot{\bar{\mathrm{S}}}\mathrm{b}\bar{\mathrm{T}}+7aq$.

Omitting a few complex organic compounds, these are all the tetragonal species in the two volumes of Rammelsberg's Crystallographic Chemistry excepting $\dot{\mathrm{A}}\mathrm{g}\ddot{\mathrm{C}}\mathrm{l}$, Hg^2Cl. Other examples might be mentioned, but the above are fully sufficient.

The correspondence with the law for tetragonal species is so general that we may reasonably believe that the apparent exceptions, where the composition and crystallization are correctly given, may be brought into conformity to it by an application of one or the other of the following principles.

a. The principle of polymerism.—Hg^2Cl is Hg^2Cl^2 in the new system of chemistry; and if the whole is doubled, it becomes Hg^4Cl^4, which is probably the true formula of this species in the tetragonal state, the only crystalline state yet known.

b. Part of the ingredients may be only accessory, or subordinate to a dominant part which determines the crystallization.—Water is commonly admitted to be present in this way in most of the compounds in which it occurs; although essential to the species, it is subordinate, crystallogenically at least, to the rest. Water is now believed to be not the only substance that may play the part of indifferentism in compounds, and many formulas have of late been written by chemists admitting this. Apophyllite is a tetragonal species consisting of $\dot{\mathrm{R}}+2\dddot{\mathrm{S}}\mathrm{i}+2\dot{\bar{\mathrm{H}}}$. Making the water basic, there is still no conformity to the type of either the unisilicates or bisilicates, the oxygen ratio for the bases and silica being 3 : 4. If half the water be regarded as basic, and the formula be written $(\dot{\mathrm{R}},\dot{\bar{\mathrm{H}}})^2\dddot{\mathrm{S}}\mathrm{i}+\dot{\bar{\mathrm{H}}}\dddot{\mathrm{S}}\mathrm{i}$, it is made to consist of a dominant part which is a unisilicate analogous to the tetragonal species meionite, mellilite, etc., and a bisilicate which is a kind of opal or waterglass, well known to be a "colloid," or uncrystallizable, and which therefore might well have no effect toward modifying the crystallization as determined by the other part.

2. *Hexagonal species, and the number* 3.—Hexagonal species have been stated to occur among the sesquioxyds (as $\mathrm{Fe^2O^3}$, $\mathrm{Al^2O^3}$, $\mathrm{Cr^2O^3}$); the bisilicates (as in beryl, eudialyte, dioptase, pyrosmalite, chabazite, gmelinite); and the carbonates (in calcite, and the allied species); in which compounds the number of atoms of oxygen is 3, or a multiple of 3. Other examples are:

Pyrargyrite and proustite, $\mathrm{3AgS+(Sb, As)^2S^3}$, in which the number of atoms of sulphur is 6; gibbsite $\dddot{\overline{\mathrm{Al}}}\dot{\mathrm{H}}^3$; alunite $\dot{\mathrm{K}}\dddot{\mathrm{S}}+3\dddot{\overline{\mathrm{Al}}}\dddot{\mathrm{S}}+6aq$; apatite $3\dot{\mathrm{C}}\mathrm{a}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{P}}}+\mathrm{CaCl}$; coquimbite $\dddot{\overline{\mathrm{F}}}\mathrm{e}\dddot{\mathrm{S}}^3+9aq$; $\mathrm{Al^2Cl^3}+12aq$; $\dot{\mathrm{M}}\mathrm{g}\dddot{\mathrm{S}}+6aq$; $\dddot{\overline{\mathrm{Al}}}\dddot{\mathrm{S}}^3+27aq$; $\mathrm{SrO\,S^2O^5}+4aq$, and the corresponding salt of lime, and of lead: $\dot{\mathrm{K}}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$; $\dot{\mathrm{N}}\mathrm{a}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$; $(\dot{\mathrm{C}}\mathrm{a}+\dot{\mathrm{H}}^2)\ddot{\mathrm{C}}$; AgO, $\mathrm{ClO^7}+4\dot{\mathrm{H}}$; $\mathrm{3NaCl+IrCl^3}+24aq$; $\mathrm{KCl+2MgCl}+12aq$; $\mathrm{MgCl+PtCl^2}+6aq$.

The exceptions to the principle are to be accounted for in the same manner as those under the tetragonal system. Along side of the hexagonal sesquioxyds, $\mathrm{Fe^2O^3}$, $\mathrm{Al^2O^3}$, $\mathrm{Cr^2O^3}$, there is the hexagonal protoxyd ZnO, similar in angle. Applying the principle of polymerism and writing the formula $\mathrm{Zn^3O^3}$, it then has, like the sesquioxyds, 3 of O. This view of the protoxyd is abundantly illustrated and sustained among the silicates. For the constitution of the larger part of them (garnet, scapolite, epidote, etc.) is based on the mutual replacement of 1 of sesquioxyds ($\mathrm{R^2O^3}$), and 3 of protoxyds (3RO); and this mutual replacement signifies isomorphism of $\mathrm{R^2O^3}$ and $\mathrm{R^3O^3}$. Again, graphite, or *hexagonal* carbon, has been shown to have its atomic weight nearly three times as great as that of ordinary carbon; and it is altogether probable, therefore, that in this hexagonal state carbon is $\mathrm{C^3}$, in accordance with the principle in view. Hexagonally crystallized water, on the same ground, is not HO, but $\mathrm{H^3O^3}$. ZnS occurs both in isometric and hexagonal forms; and while the former may be simply ZnS, the latter should be $\mathrm{Zn^3S^3}$; and so for the hexagonal sulphid of Fe, Ni, Cd, we should have $\mathrm{Fe^3S^3}$ (troilite, pyrrhotine); $\mathrm{Ni^3S^3}$ (millerite); $\mathrm{Cd^3S^3}$ (greenockite); and similarly $\mathrm{Ni^3As^3}$ (copper nickel); $\mathrm{Ni^3Sb^3}$ (breithauptite).

3. *Isometric system.*—The number of atoms of the negative element in isometric species appears to be either 1, 2, 3, 4, or a multiple of 3 or 4; and this diversity accords with the twofold nature of a cube; that is, (1) an equiaxial square prism, and (2) (if a diagonal be made vertical) a rhombohedron of 90°; for it has this double relation to other forms. Accordingly, isometric forms occur among protoxyds, protosulphids, protochlorids, etc.; also deutoxyds; also unisilicates; in leucite, analcime; also in—

$\dot{\mathrm{M}}\mathrm{g}^3\ddot{\mathrm{B}}^4$, or boracite; $\dddot{\overline{\mathrm{A}}}\mathrm{s}$; $\dddot{\overline{\mathrm{S}}}\mathrm{b}$; $\dot{\mathrm{N}}\mathrm{a}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{C}}\mathrm{l}$; $\dot{\mathrm{K}}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{B}}\mathrm{r}$; $\dot{\mathrm{N}}\mathrm{a}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{B}}\mathrm{r}$; $\dot{\mathrm{N}}\mathrm{i}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{C}}\mathrm{l}+6aq$; $\dot{\mathrm{C}}\mathrm{u}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{C}}\mathrm{l}+6aq$; $\dot{\mathrm{C}}\mathrm{o}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{B}}\mathrm{r}+6aq$; $\mathrm{AmCl+SnCl^2}$; $\mathrm{KCy+AgCy}$; $3\dot{\mathrm{N}}\mathrm{a}\ddot{\overline{\mathrm{C}}}+\ddot{\overline{\mathrm{C}}}\mathrm{r}\ddot{\overline{\mathrm{C}}}^3+9aq$; the alums, which have 16O, besides 24O in the water; $\dot{\mathrm{N}}\mathrm{a}\overline{\mathrm{A}}\mathrm{c}+2\dddot{\overline{\mathrm{U}}}\overline{\mathrm{A}}\mathrm{c}$; $\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{W}}+\dddot{\mathrm{W}}\dddot{\mathrm{W}}$.

Important chemical and crystallographic conclusions flow from the principle which has been explained, if it is sustained, as we believe, by the facts. A few only are briefly touched upon.

1. It follows that the hexagonal state of the *elements* may be one corresponding to 3R, or 3*n*R; that while zinc in the isometric state if such exists (about which there is doubt) is Zn; in the hexagonal it may be Zn^3, the same state in which it exists in hexagonal oxyd of zinc. So also Pd, As, Sb, may represent the isometric state of the elements palladium, arsenic, antimony; but Pd^3, As^3, Sb^3, the hexagonal; and so for other cases.

2. The oxyd of copper, CuO, which may also be written $ȻuO^2$, is dimorphous, it occurring both in isometric and orthorhombic forms; and the orthorhombic form is closely isomorphous with TiO^2 in brookite—*I*: *I* and *I*: ½ in the oxyd of copper being respectively 99° 39′ and 126° 29′, and in brookite 99° 50′ and 126° 15′. This relation to TiO^2 shows that the orthorhombic state of the cupric oxyd should have the formula $ȻuO^2$, or that of a deutoxyd, and the isometric alone that of CuO. And it indicates further that the element copper may exist theoretically, if not actually, in two corresponding polymerous states.

3. As long since illustrated by Laurent, the protoxyds RO, sesquioxyds R^2O^3, deutoxyds RO^2, and other grades of oxyds RO^3, RO^5 (and the same in corresponding chlorids, sulphids, etc.), in which 1 part of oxygen balances, in its affinity, 1, ⅔, ½, etc., parts of the basic element (as is seen on dividing by the number of atoms of oxygen so as to reduce the oxygen in all the above formulas to 1O), may be viewed as containing the basic element in as many different states as there are grades of the above compounds. For convenience these states may be designated by using the Greek letters as follows:

Formulas	RO RO	R^2O^3 $R_{\frac{2}{3}}O$	RO^2 $R_{\frac{1}{2}}O$	RO^3 $R_{\frac{1}{3}}O$	RO^5 $R_{\frac{1}{5}}O$
States of Basic element	R αR	$R_{\frac{2}{3}}$ βR	$R_{\frac{1}{2}}$ γR	$R_{\frac{1}{3}}$ δR	$R_{\frac{1}{5}}$ εR

or the *alpha*, *beta*, *gamma*, *delta* and *epsilon* states. It is observed that $3RO=R^3O^3$; $3(\beta RO)=R^2O^3$; $2(\gamma RO)=RO^2$; $3(\gamma RO)=\frac{3}{2}RO^2$; $3(\delta RO)=RO^3$; and so on: in other words, the *one* molecule R^2O^3 corresponds to *three* of βRO; and in 3(βRO) there are as many atoms of the basic element βR as of O.

Now, if a sesquioxyd occurs in *isometric* crystals, as supposed to be true of Fe^2O^3 (but reasonably doubted), that sesquioxyd is not Fe^2O^3, but may be $Fe_{\frac{2}{3}}O$. This is but the converse of the conclusion, stated above, that if a protoxyd occurs in *hexagonal* crystals it is not then RO, but may be R^3O^3. So in other cases: if oxyd of tin had an isometric as well as a tetragonal form, the former in the crystalline state should be $Sn_{\frac{1}{2}}O$, and only the latter

SnO^2. A metal in the different states R, $R_{\frac{2}{3}}$, $R_{\frac{1}{2}}$, has, accordingly, the same isomorphic power; and so also, 2R, $2R_{\frac{2}{3}}$, $2R_{\frac{1}{2}}$; and 3R, $3R_{\frac{2}{3}}$, $3R_{\frac{1}{2}}$. Hence under the principle explained—

RO, $R_{\frac{2}{3}}O$, $R_{\frac{1}{2}}O$ should be alike *isometric* in crystallization.
2(RO), $2(R_{\frac{2}{3}}O)$, $2(R_{\frac{1}{2}}O)$ may be *tetragonal* " "
3(RO), $3(R_{\frac{2}{3}}O)$, $3(R_{\frac{1}{2}}O)$ may be *hexagonal* " "

Quartz, which is hexagonal silica, should, according to the above, be $3(Si_{\frac{1}{2}}O)$, or else $6(Si_{\frac{1}{2}}O)$, and not $2(Si_{\frac{1}{2}}O) = SiO^2$. SiO^2 is hence unknown in the crystalline state; and if ever obtained crystallized it will in all probability have one of the forms of TiO^2. Common uncrystallizing silica, or opal-silica, low in density, may be silica in the isometric form, or $Si_{\frac{1}{2}}O$, but with so feeble crystallizing power as never to exhibit any thing but the so-called *colloid* condition. Whether isometric silicon, crystals of which have been obtained artificially, is simply silicon in the *alpha* state, or not, cannot be at once decided; for it is probable that diamond, which is isometric carbon, is equivalent to C^4, its density, and the product of the atomic weight by the specific heat, indicating this relation to graphite.* As "graphitoidal" silicon has turned out to be only isometric silicon, we have no chance for a comparison, like that with respect to carbon.

Anatase is probably TiO^2, and rutile Ti^2O^4, the density of the latter being 4·2, of the former only 3·9. The relations of hausmannite and braunite (p. 90, note) accord with this, the latter containing *two of hausmannite*. Brookite is intermediate in density, and in the temperature of origin, and hence may be $\frac{3}{2}(TiO^2)$. It would appear, therefore, that the species of *highest polymerous state*, rutile, forms at the highest temperature.

4. The views illustrated sustain the conclusion that the different states of elements represented above are fundamentally distinct: that Fe in the *alpha* state is related to all other metals that are in the same state, including K, Na (K_2, Na_2 in the new system of chemistry), as well as Mg, Ca, etc.; that Fe, Cr, Co, in the *beta* state are of the same group of elements with aluminum in alumina: that Fe, Mn, Cu, Pb in the *gamma* state should be classed with Ti, Sn.

5. Aid is given by the principle explained toward determining in many cases what are the accessory and what the dominant ingredients in a compound, and thence what should be regarded as its true constitution.

6. Crystallogeny hereby learns that *quadratic or tetragonal symmetry in crystals depends on quadratic symmetry, or the recurrence*

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* For this inference with regard to the equivalent of carbon in the diamond I am indebted to Prof. G. F. Barker, who offered it while I was explaining to him the views contained in this paper.

of fours, in the number of atoms of the negative part of a compound; and hexagonal symmetry, in like manner, on the presence of triads or hexads of the same atoms. Moreover, on the view explained, the number of atoms of the more positive element or elements, in the simpler compounds at least, may be just equal to that of the negative. For since $3(\alpha RO)=R^3O^3$, $3(\beta RO)=R^2O^3$, and $3(\delta RO)=RO^3$, there are, in these oxyds, as many atoms of αR, βR, δR, as of O; and if the elements may exist in these divided states, they may thus make with the O the crystallogenic molecule.

The precise arrangement of the constituent atoms in a molecule subsisting in any case, and producing the characteristics and special dimensions of the crystal, yet remains to be explained. This much may be safely deduced: that the negative atoms must be grouped—and in the systems here referred to, under quadrate or hexad symmetry—at or toward one extremity of the molecule, and the positive at or toward the opposite; and that the molecule in this way derives its polarity—a characteristic abundantly manifested in the formation, the forms, and the physical natures of crystals,* though not often apparent in mechanical effects, and which is in accordance with the most fundamental of nature's laws. The different constituent elements or parts of a compound may differ in *degree* of negativity or positivity, and even the same element may be present in opposite states; such constituents would have their places accordingly, though with subordinate groupings according to special affinities.

In order not to be misunderstood, I here state, formally, what has been more than once implied in the foregoing, that, while, according to the principle advanced, tetragonal and hexagonal forms depend on the numbers 4 and 3, as explained, the presence of these numbers by no means necessitates the occurrence of these forms. Multitudes of examples illustrate this: the dimorphism of TiO^2 is one. I would also remark that I express no opinion as to whether the molecule of a compound consists of the positive and negative atoms simply juxtaposed, or whether these so-called atoms are composed of particles, and there is a different disposition in the molecule; and assert only that, whatever the fact on this point, there is tetragonal symmetry in the constitution of the molecule in the tetragonal system, and hexagonal in the hexagonal system.

I leave the subject here, without discussing at present the methods by which *orthorhombic* and *clinohedral* forms are produced; only observing that orthorhombic and monoclinic forms occur under all numbers of atoms of the negative element, from 1 (or 2) as in sulphur, upward; and, therefore, although polymerism may turn the 2 of sulphur (and so, other numbers) into various multiples of the same, yet that the production of these forms does not depend simply on numbers.

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* **See articles I and II referred to on page 89.**

Art. XIII.—*The Glaciers of Alaska, Russian America;* by William P. Blake.*

On approaching the northwest coast of America from the west the mountain chain of the interior is seen to be lofty and alpine in its character. The ridges are sharply serrated, and rise here and there into needle-like pinnacles, giving an outline against the sky that contrasts strongly with the gently sloping sides of the truncated cone of Edgecombe, a fine extinct volcano which marks the entrance to the harbor of Sitka.

The rocky peaks of the interior rise above broad fields of snow, which give birth to numerous glaciers, while Edgecombe, and the ridges upon the coast, are in great part covered with a dense forest of pines and firs. No glaciers are found upon the coast at Sitka or south of it, for under the influence of the warm currents of the Pacific, the climate is comparatively mild, while a short distance in the interior, the winters are almost Arctic in severity.

The principal stream in the vicinity of Sitka, is the Stickeen; which rises in the "Blue Mountains," opposite the head-waters of the Mackenzie, and flows in a general southeasterly direction parallel with the coast until it breaks through the mountains east, and a little north, of Sitka. When the snows are melting, the river becomes much swollen and is then navigable with difficulty by small steamboats for about 125 miles above its mouth. The valley is generally narrow and the river is not bordered by a great breadth of alluvial land.

In ascending this river one glacier after another comes into view; all of them are upon the right bank of the stream and descend from the inner slope of the mountain range. There are four large glaciers and several smaller ones visible within a distance of 60 or 70 miles from the mouth.

The first glacier observed, fills a rocky gorge of rapid descent, about two miles from the river, and looks like an enormous cascade. The mountains are greatly eroded by it, for it is overhung by freshly broken cliffs of rock evidently produced by the glacier.

The second glacier is much larger, and has less inclination. It sweeps grandly out into the valley from an opening between high mountains from a source that is not visible. It ends at the level of the river in an irregular bluff of ice, a mile and a half or two miles in length, and about 150 feet high. Two or more terminal moraines protect it from the direct action of the stream. What

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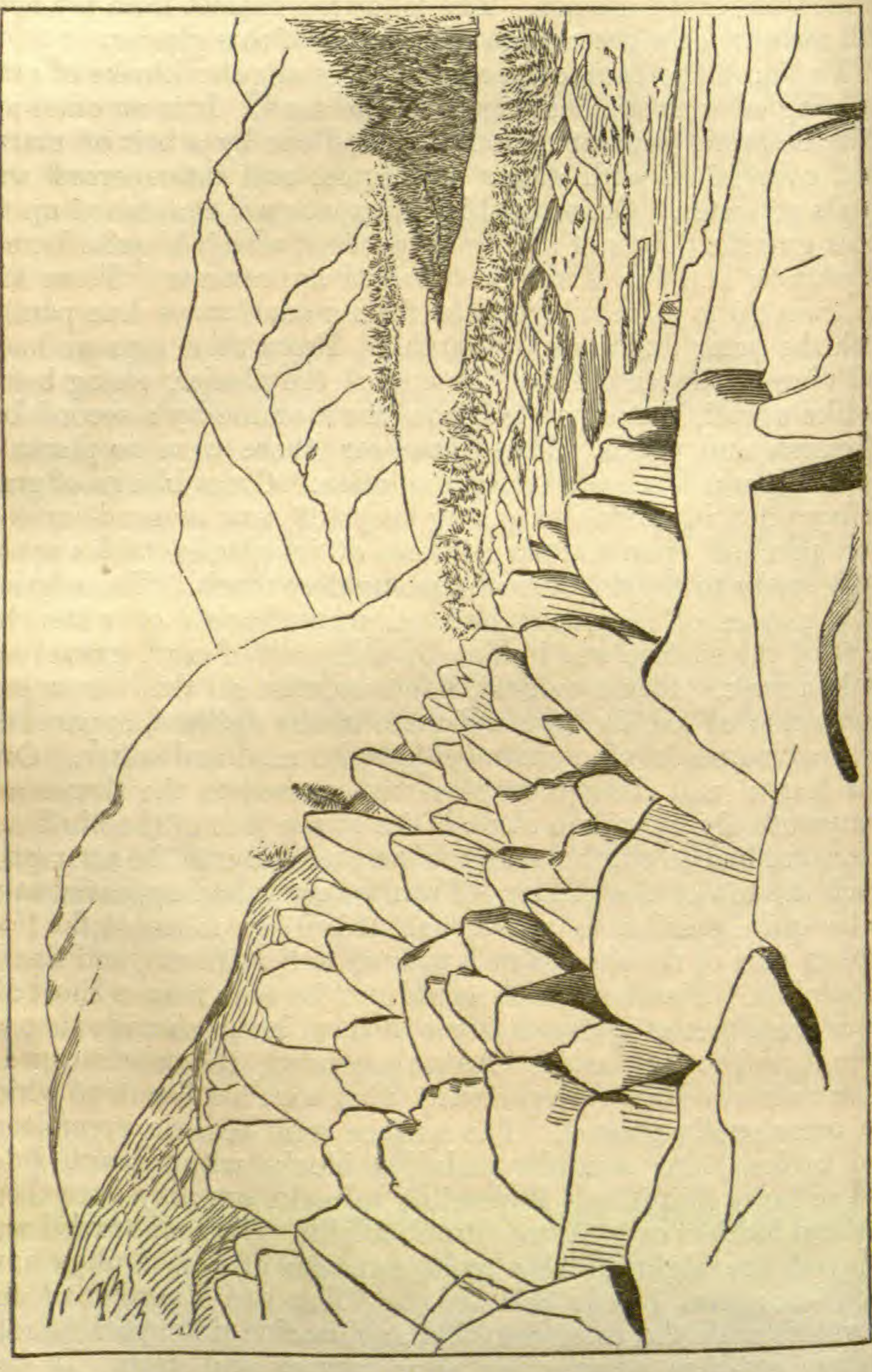
* The observations upon which this article is based were made in May, 1863, while a guest on his Imperial Russian Majesty's Corvette "Rynda," Commander Banarguine, by whose courtesy the writer accompanied Lt. Pereleshin on a reconnaissance, in a whale boat, of the Stickeen river, under the orders of Admiral Popoff. —W. P. B.

at first appeared as a range of ordinary hills along the river, proved on landing to be an ancient terminal moraine, crescent-shaped, and covered with a forest. It extends the full length of the front of the glacier. The following extract from my notes will answer for a description of the end of this glacier.

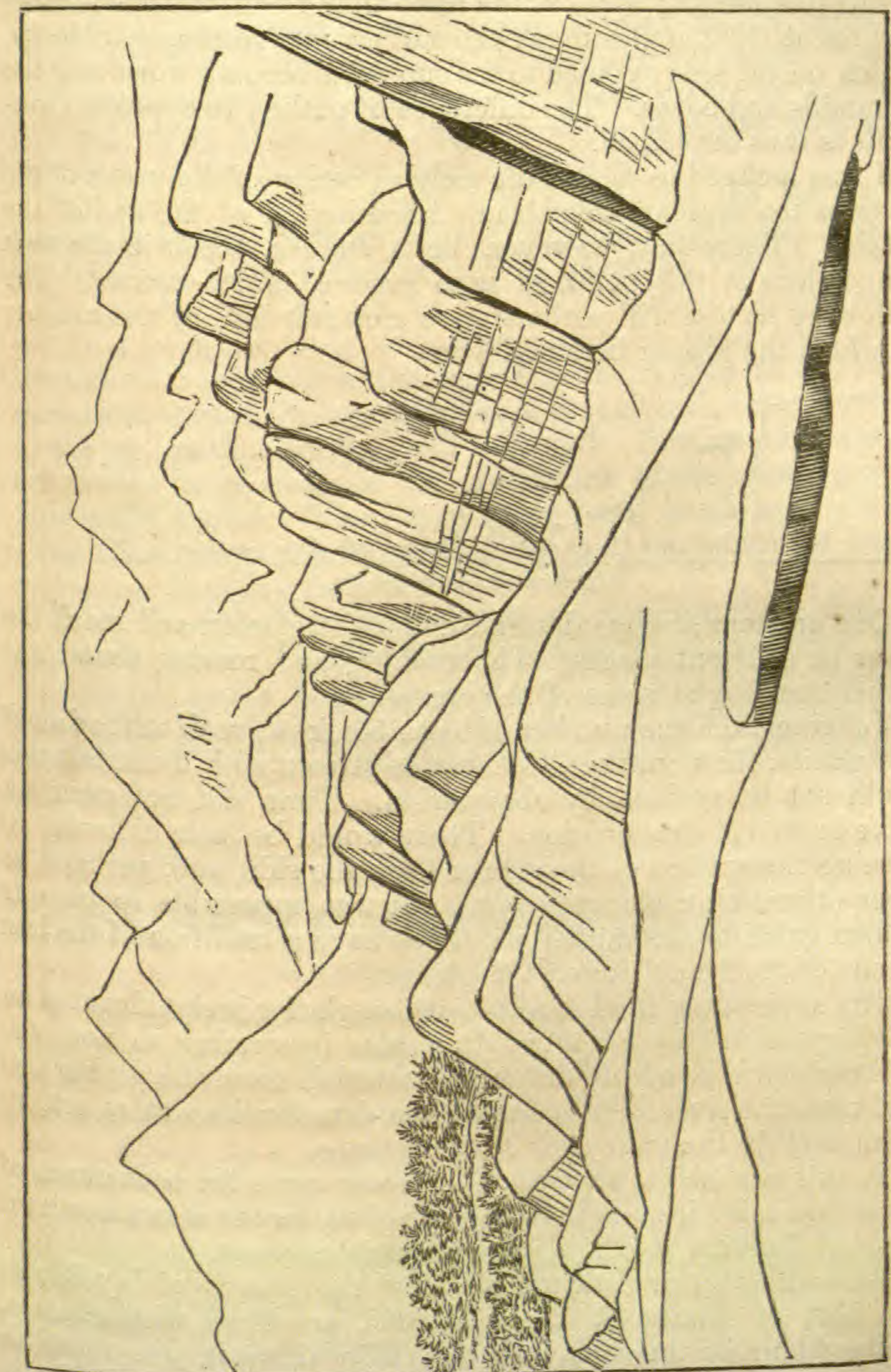
We found the bank composed of large angular blocks of granite mingled with smaller fragments and sand. It is an outer and older moraine, separated from a second one by a belt of marsh-land overgrown with alders and grass, and interspersed with ponds of water. Crossing this low space we clambered up the loose granitic debris of the inner moraine, which is quite bare of vegetation and has a recently formed appearance. These hills are from 20 to 40 feet high, and form a continuous line parallel with the outer and ancient moraine. From their tops we had a full view of the ice cliffs of the end of the glacier, rising before us like a wall, but separated from the moraine by a second belt of marsh and ponds. Here, however, there were no plants or trees. It was a scene of utter desolation. Great blocks of granite lay piled in confusion among heaps of sand or sand-cones or were perched upon narrow columns of ice-glacier tables apparently ready to topple over at the slightest touch. The edges of great masses of ice could be seen around pools of water, but most of the surface was hidden by a deposit of mud, gravel and broken rock. It was evident, however, that all this was upon a foundation of ice, for here and there it was uplifted, apparently, in great masses leaving chasms filled with mud and water. Over this fearful and dangerous place we crossed to the firmer and comparatively unbroken slope of ice at the foot of the bluff, and afterward had to climb over snow and ice only, in the attempt to reach the top of the glacier. From below it had appeared to us to be quite possible to accomplish this if we followed the least broken part of the slope, but it proved to be difficult, and finally impossible. Fissures which could not be seen from a short distance were met at intervals, some of them being so wide that we were forced to turn aside. As we ascended, the crevasses were more numerous but were generally filled with hard snow to which we occasionally trusted. The surface soon became precipitous and broken into irregular stair-like blocks with smooth sides and so large that it was impossible to make our way over them without ladders or tools to cut a foothold. Here we turned and enjoyed the sight of this great expanse of ice, broken into such enormous blocks and ledges. The sun illuminated the crevasses with the most beautiful aquamarine tints, passing into a deep sea-blue where they were narrow and deep. In one direction the ice presented the remarkable appearance of a succession of cones or pyramids with curved sides. In the opposite direction and at the same level the outlines were totally different, showing merely a succession of terraces or steps inclined

1.



inward toward the glacier and broken by longitudinal crevasses. The annexed sketches were made from this point of view. No. 1 is taken looking up the river, over the end of the glacier, and shows the pyramids of ice. The line of ponds, and the two moraines are seen at the base, and the river on the extreme right. No. 2 shows the appearance of the glacier in the opposite direction. A broad fissure between one level of the ice and the next is filled with snow.

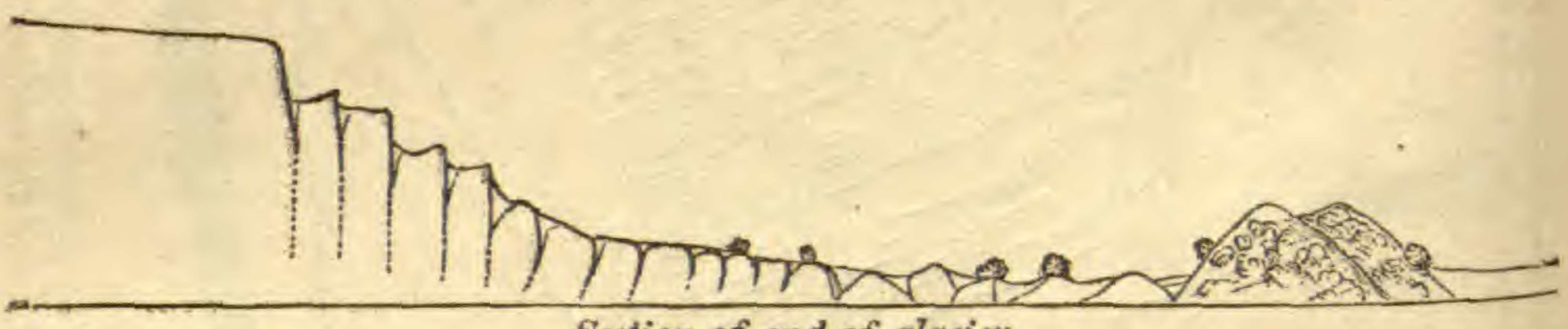
2.



Bluffs of ice. End of Glacier, looking toward the southeast.

It is evident that this glacier breaks down in a series of great steps or ledges along the greater part of its front. These steps rise for 20 to 30 feet one above the other and thus produce a stair-like ascent, while at the same time the numerous parallel fissures at right angles break the surface into rectangular blocks, which on the side exposed to the sun soon become worn into the pyramids and cones. The difference of outline in opposite directions is thus explained.

I was inclined to regard the melting action of the water of the river as the cause of this abrupt breaking off of the end of the glacier. There may, however, be a sudden break in the rock foundations at this point, so as to produce an ice-cascade. The following section will perhaps give a clearer idea of the manner in which the glacier breaks down.



Section of end of glacier.

One or more streams descend under the glacier, and reach the river at different places. The rushing and roaring sound was rather startling at some of the crevasses.

Judging from the number of loose blocks of rock at the foot of the glacier, the upper surface must be strewn with them, but this could not be verified by observation. Time did not permit a more extended examination. There would be little difficulty in gaining the surface of the glacier from the side, and, perhaps, at some other points along its front. It was impossible to get our Indian guide to accompany us. They have a tradition of the loss of one of their chiefs upon this glacier.

The ancient terminal moraine of this glacier is significant of an amelioration of the climate. It is also interesting to note the effect which this accumulation of materials from the glacier has had upon the river. It has acted as a dam for the waters, setting them back in the valley for some distance.

In this connection the following notes upon the occurrence of great bodies of ice, undoubtedly glaciers, in the more northern parts of Russian America have a special interest.

According to Sir Edward Belcher* the shores of Icy Bay at the foot of Mount St. Elias, lat. 60°, are lined with glaciers. "The whole of this Bay, and the valley above it, was found to be composed of (apparently) snow-ice, about 30 feet in height at the water cliff, and probably based on a low muddy beach." At Cape Suckling in the same latitude and west of Icy Bay the

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* Voyage of the Sulphur, i, 78–80.

same voyager observed a vast mass of ice sloping to the sea, the surface of which presented a most singular aspect, being "one mass of four-sided truncated pyramids." He was not able to account for this and observes "What could produce these special forms? If one could fancy himself perched on an eminence about 500 feet above a city of snow-white pyramidal houses, with smoke-colored flat roofs covering many square miles of surface and rising ridge above ridge in steps, he might form some faint idea of this beautiful freak of Nature."

Vast bodies of ice terminating in cliffs upon the sea are numerous in Prince William Sound, and the thundering noise of the falling of large masses of ice was heard by Vancouver.*

On the shores of an arm of Stephens Passage (northwest of Sitka) a compact body of ice extended for some distance at the time of Vancouver's visit, and from the rugged valleys in the mountains around, immense bodies of ice reached perpendicularly to the sea, so that boats could not land. Similar observations are made, in general, of the mountains of the coast opposite Admiralty island. Two large open bays north and west of Point Couverdeen are terminated by solid mountains of ice rising perpendicularly from the water's edge.

From these various observations we may conclude that the mountain region of Russian and British North America, from latitude 55° to the Polar sea, is dotted with glaciers cutting and scoring the mountains as they descend, and pushing their accumulations of rocky debris either into the ocean, or the rivers of the interior.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the influence of the adhesion of vapor in experiments upon the absorption of heat.*—The subject of the absorption of radiant heat by aqueous vapor has been again taken up by Magnus who has succeeded in pointing out the source of error which affected the experiments of Tyndall and of Wild.† In a previous memoir Magnus had endeavored to shew that vesicular vapor absorbs heat more powerfully than dry air, but that air loaded with transparent vapor has no greater absorptive power than air which contains no vapor at all. Tyndall replied to this paper, and the subject was then examined independently by Wild, who fully confirmed the results of Tyndall. In his new investigation Magnus employed an apparatus of the same dimensions with that of Wild and of similar construction. Experiment soon proved that the walls of the tubes containing the dry or moist air through which the radiant heat passed exercised a

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* Vancouver's Voyages, iii, 185, (1794), quoted by Findlay, Directory of Pacific Ocean, i, 479.

† Pogg. Ann., cxxix, 57.

powerful influence upon the absorption. Thus a tube coated internally with lamp-black produced an effect precisely the opposite of that which was observed when a polished tube was employed. In this case an increase in the amount of heat transmitted was observed when moist air was blown into the tube and a diminution with dry air, while the contrary takes place when a polished tube is used. Magnus proved that a layer of water is deposited upon the inside of the tube throughout its whole length, by shewing that the tube itself becomes warmer whenever moist air is thrown in. This layer of water absorbs more heat than the polished wall of the tube would do if dry, and consequently reflects less to the thermo-electric pile. Experiment showed that the quantity of heat reflected to the pile by the dry wall of a polished brass tube filled with dry air was about six times as great as that which the pile received directly when the tube was removed. Every diminution in the reflecting power of the tube must therefore greatly diminish the quantity of heat received by the pile. In a blackened tube the particles of carbon act as absorbents like the particles of water, only in a higher degree, consequently their absorption is but little increased by the deposition of water.

Hence there is no sensible cooling when moist air is blown into a tube lined with velvet or blackened inside, but on the contrary a rise of temperature which depends on the heat given out by the condensation. By employing two concentric tubes the space between which could be filled with water at different temperatures, Magnus found that when the inner tube had exactly the temperature of the air blown into it, it behaved precisely like the brass tube mentioned above. When the temperature of the inner tube was a few degrees lower than that of the moist air thrown in, the temperature of the pile diminished in a very marked degree, but reached its minimum much more slowly than when the tube had the same temperature as the air thrown in. This doubtless arose from the fact that the greater quantity of condensed vapor made a greater quantity of moist air necessary, the admission of which required a longer time. Further experiments distinctly proved that a condensation of vapor upon the walls of the tube took place even when the moist air blown in was far from its point of saturation. The vapors of alcohol exhibited the same phenomena as those of water, only in a higher degree. In addition, however, it was found that the vapor of alcohol itself exerts a powerful absorbent action upon radiant heat, which is not the case with the vapor of water. The author concludes from his experiments, that the apparent absorption of heat by aqueous vapor observed by Tyndall and Wild is due simply to the effect of the condensation of water upon the sides of the containing tubes, and not to any specific absorptive power in the vapor itself.—*Pogg. Ann.*, cxxx, 207. W. G.

2. *On fluosalts of antimony and arsenic.*—Marignac has examined the action of fluohydric acid upon antimonic and arsenic acids and the corresponding salts. Antimonic acid dissolves in fluohydric acid and gives a fluorid which could not be obtained crystallized but which may be evaporated to a gummy consistency. This fluorid unites readily with alkaline fluorids to form crystalline salts, which are very soluble and more or less deliquescent, their solutions are not precipitated—at least at first—by acids, sulphuretted hydrogen, caustic alkalies, or carbonates. The crys-

talline salts may be kept without decomposition, but by repeated evaporation they pass into oxyfluoantimonates. The salt SbF_5KF is formed when the gummy antimonate of potash is dissolved in fluohydric acid and the solution evaporated. It crystallizes in thin anhydrous leaves. With an excess of fluorid of potassium this salt gives $\text{SbF}_5, 2\text{KF}+2\text{H}_2\Theta$ in beautiful very brilliant prisms derived from an oblique rhombic prism. A fluo-oxyantimonate of sodium $\text{Sb}\Theta\text{F}_3, \text{NaF}+\text{H}_2\Theta$ is obtained by adding carbonate of soda to a solution of fluorid of antimony in an excess of fluohydric acid and separates in small deliquescent hexagonal prisms. When this last salt is dissolved in fluohydric acid, another crystalline soda salt is obtained having the formula SbF_5, NaF. Two crystalline ammonium salts have respectively the formulas $\text{SbF}_5, \text{NH}_4\text{F}$ and $2(\text{SbF}_5, 2\text{NH}_4\text{F})+\text{H}_2\Theta$.

The fluo-arsenates are still more easily soluble than the fluo-antimonates and therefore more difficult to obtain pure. Marignac describes crystalline salts having respectively the formulas $2(\text{AsF}_5, \text{KF})+\text{H}_2\Theta$; $\text{As}\Theta\text{F}_3, \text{KF}+\text{H}_2\Theta$; $\text{AsF}_5, 2\text{KF}+\text{H}_2\Theta$; and $\text{As}_2\Theta\text{F}_8, 4\text{KF}+3\text{H}_2\Theta$; which last is perhaps $\text{As}\Theta\text{F}_3, 2\text{KF}+\text{AsF}_5, 2\text{KF}+3\text{H}_2\Theta$.—*Zeitschrift für Chemie*, iii, 107.

W. G.

[*Note.*—The salts described by Marignac are of special interest as showing the relationship of niobium and tantalum to the nitrogen group. A comparison of the formulas of the fluorine compounds of arsenic and antimony with those of niobium and tantalum already described in this Journal will remove any doubt as to the pentatomic character of the metals last named, and as to the natural group of elements to which they belong.—W. G.]

3. *Action of the hydracids upon ethers.*—GAL has shown that the action of the hydracids upon both simple and compound ethers, is precisely analogous to that which these acids exert upon the anhydrids, already published by him.

If we let A represent a negative or acid radical, and B a positive or alcoholic one, the formation of a compound ether may be expressed thus:

$$A\text{Cl}+\left.\begin{matrix}B\\ \text{H}\end{matrix}\right\}\Theta=\left.\begin{matrix}B\\ A\end{matrix}\right\}\Theta+\text{HCl}.$$

Now it is evident that the reaction in the inverse direction will be

$\left.\begin{matrix}B\\ A\end{matrix}\right\}\Theta+\text{HBr}=\left.\begin{matrix}A\\ \text{H}\end{matrix}\right\}\Theta+B\text{Br}$: rather than $\left.\begin{matrix}B\\ A\end{matrix}\right\}\Theta+\text{HBr}=\left.\begin{matrix}B\\ \text{H}\end{matrix}\right\}\Theta+A\text{Br}$; since in the latter case we return to our starting point. To confirm this theoretic view, Gal undertook the present research.

In these experiments, hydrobromic acid was the acid generally used; and the compound ethers employed were those formed with methyl and ethyl, by the fatty acid series $\text{Є}_n\text{H}_{2n}\Theta_2$; the aromatic acid series, $\text{Є}_n\text{H}_{2n-8}\Theta_2$; the oxalic acid series, $\text{Є}_n\text{H}_{2n-2}\Theta_4$; the carbonic acid series, $\text{Є}_n\text{H}_{2n}\Theta_3$; and by nitric acid. The ether was saturated with hydrobromic acid gas, and exposed in a sealed tube, to an elevated temperature for some hours. And in every case the decomposition was found to take place according to the equation given above, methylic or ethylic bromid being produced, and the acid of the ether being set free.

On the alcohols, hydrobromic acid acts thus:—

$$\left.\begin{matrix}B\\ \text{H}\end{matrix}\right\}\Theta+\text{HBr}=\left.\begin{matrix}\text{H}\\ \text{H}\end{matrix}\right\}\Theta+B\text{Br},$$

showing that we may consider alcohols as compound ethers, in which hydrogen acts the part of a negative radical. With the simple ethers, if the hydrobromic acid be in excess we have:—

$$\left.\begin{matrix}B\\B\end{matrix}\right\}\Theta+(\mathrm{HBr})_2=\left.\begin{matrix}\mathrm{H}\\\mathrm{H}\end{matrix}\right\}\Theta+(B\mathrm{Br})_2,$$

but if the ether be in larger proportion, then

$$\left.\begin{matrix}B\\B\end{matrix}\right\}\Theta+\mathrm{HBr}=\left.\begin{matrix}B\\\mathrm{H}\end{matrix}\right\}\Theta+B\mathrm{Br}.$$

The mercaptans give rise to two reactions. First we have

$$\left.\begin{matrix}B\\\mathrm{H}\end{matrix}\right\}\text{Ꞩ}+\mathrm{HBr}=\left.\begin{matrix}\mathrm{H}\\\mathrm{H}\end{matrix}\right\}\text{Ꞩ}+B\,\mathrm{Br},$$

and secondly $\left.\begin{matrix}B\\\mathrm{H}\end{matrix}\right\}\text{Ꞩ}+(B\,\mathrm{Br})_2=\left.\begin{matrix}B\\B\\B\\\mathrm{Br}\end{matrix}\right\}\text{Ꞩ}+\mathrm{HBr}$. The simple sulphur ethers act similarly; the first reaction is $\left.\begin{matrix}B\\B\end{matrix}\right\}\text{Ꞩ}+\mathrm{HBr}=\left.\begin{matrix}B\\\mathrm{H}\end{matrix}\right\}\text{Ꞩ}+B\mathrm{Br}$, the second $\left.\begin{matrix}B\\\mathrm{H}\end{matrix}\right\}\text{Ꞩ}+\mathrm{BBr}=\left.\begin{matrix}B\\B\\B\\\mathrm{Br}\end{matrix}\right\}\text{Ꞩ}$, as Cahours has also shown.—*Ann. Ch. Phys.*, IV, x, 5.

4. *On new mixed acids.*—In a more recent paper, GAL has described some new mixed acids which he has produced. Reasoning from the well known fact that by the action of potassic hydrate upon monobromacetic acid, glycollic acid is formed, according to the equation

$$\left.\begin{matrix}\text{Ꞓ}_2\overparen{\mathrm{H}_2}\mathrm{Br}\Theta\\\mathrm{H}\end{matrix}\right\}\Theta+\left.\begin{matrix}\mathrm{K}\\\mathrm{H}\end{matrix}\right\}\Theta=\left.\begin{matrix}\text{Ꞓ}_2\overparen{\mathrm{H}_2}(\mathrm{H}\Theta)\Theta\\\mathrm{H}\end{matrix}\right\}\Theta+\mathrm{KBr},$$

(or, as is more clearly exhibited in Frankland's notation,

$$\left\{\begin{matrix}\mathbf{C}\mathrm{H}_2\mathrm{Br}\\\mathbf{C}\Theta\,\mathrm{Ho}\end{matrix}\right.+\mathrm{KHo}=\left\{\begin{matrix}\mathbf{C}\mathrm{H}_2\mathrm{Ho}\\\mathbf{C}\Theta\mathrm{Ho}\end{matrix}\right.+\mathrm{KBr}),—$$

the change being the substitution of Ho($=\mathrm{H}\Theta$, hydryl) for Br,—Gal concluded that the similar univalent radical oxacetyl,* in potassic acetate, might be similarly exchanged. Though in the discovery of such mixed acids, Gal has been anticipated by Strecker, Wurtz and others, he has in the present research added several new ones to the list.

By heating to 100° C. in a sealed tube, an alcoholic solution of ethylic monobromacetate with potassic acetate, he obtained a liquid having a density about 1, whose boiling point was 180° C., and whose formula, as given by analysis, was $\text{Ꞓ}_6\mathrm{H}_{10}\Theta_4$. When heated in a sealed tube with an alcoholic solution of potassic hydrate, it was decomposed, yielding potassic acetate and glycollate, and alcohol. If it be treated with solid potash, and distilled, acetic ether passes over, and potassic glycollate remains in the retort. From these reactions, Gal infers that the liquid above mentioned is the ether of an acid formed from glycollic acid by replacing its hydryl by the radical oxacetyl, and which he calls aceto-glycollic acid. Its formation is thus represented: $\left\{\begin{matrix}\mathbf{C}\mathrm{H}_2\mathrm{Br}\\\mathbf{C}\Theta\mathrm{Eto}\end{matrix}\right.+\left\{\begin{matrix}\mathbf{C}\mathrm{H}_3\\\mathbf{C}\Theta\mathrm{Ko}\end{matrix}\right.=\left\{\begin{matrix}\mathbf{C}\mathrm{H}_2\mathrm{Aco}\\\mathbf{C}\Theta\mathrm{Eto}\end{matrix}\right.+\mathrm{KBr}.$

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* Oxacetyl, Aco $=(\text{Ꞓ}_2\mathrm{H}_3\Theta_2)$.

By alcoholic potash it breaks up thus:

$$\left\{\begin{matrix}\mathbf{C}H_2Aco\\ \mathbf{C}\Theta Eto\end{matrix}\right. +(KHo)_2=\left\{\begin{matrix}\mathbf{C}H_2Ho\\ \mathbf{C}\Theta Ko\end{matrix}\right. +\left\{\begin{matrix}\mathbf{C}H_3\\ \mathbf{C}\Theta Ko\end{matrix}\right. +\left\{\begin{matrix}\mathbf{C}H_3\\ \mathbf{C}H_2Ho.\end{matrix}\right.$$

By solid potash as follows: $\left\{\begin{matrix}\mathbf{C}H_2Aco\\ \mathbf{C}\Theta Eto\end{matrix}\right. +KHo=\left\{\begin{matrix}\mathbf{C}H_2Ho\\ \mathbf{C}\Theta Ko\end{matrix}\right. =\left\{\begin{matrix}\mathbf{C}H_3\\ \mathbf{C}\Theta Eto.\end{matrix}\right.$
The ordinary compound ethers when distilled with potash, produce alcohol, and a salt of the acid they contain; while these mixed-acid ethers yield either a salt and a more simple ether; or two salts and alcohol.

This view of its constitution, Gal proposed to confirm by submitting the new ether to the action of the hydracids according to the method given in the preceding section. He saturated therefore several grams of this aceto-glycollic ether with hydrobromic acid gas, and heated to 100° C. After repeating this process several times, the product was distilled on the water bath. The distillate was pure ethylic bromid. A viscous mass was left in the retort which upon examination proved to be a mixture of acetic and monobromacetic acids; the action of the hydracid being $\left\{\begin{matrix}\mathbf{C}H_2Aco\\ \mathbf{C}\Theta Eto\end{matrix}\right. +(HBr)_2=EtBr+\left\{\begin{matrix}\mathbf{C}H_2Br\\ \mathbf{C}\Theta Ho\end{matrix}\right. +\left\{\begin{matrix}\mathbf{C}H_3\\ \mathbf{C}\Theta Ho\end{matrix}\right.$ in perfect accordance with the generalization above given.

Gal prepared also ethylic butyro-glycollate, $\left\{\begin{matrix}\mathbf{C}H_2Buo\\ \mathbf{C}\Theta Eto\end{matrix}\right.$, by treating potassic butyrate with ethylic monobromacetate; ethylic butyro-butyllactate (better butyro-oxybutyrate), $\left\{\begin{matrix}\mathbf{C}EtHBuo\\ \mathbf{C}\Theta Eto\end{matrix}\right.$; and ethylic aceto-oxybutyrate $\left\{\begin{matrix}\mathbf{C}EtHAco\\ \mathbf{C}\Theta Eto\end{matrix}\right.$. The last is isomeric with butyro-glycollic ether, both containing $\mathbf{C}_7H_{14}\Theta_4$. The number of mixed acids which can thus be formed is, as Gal observes, very great; especially when not only the mono-brominated fatty acids, but also the di- and tribrominated bodies of this series are used as starting points.—*Bull. Soc. Ch.*, II, vii, 329, April, 1867.

5. *On some new compounds of silicon.*—In a series of researches upon silicon and its compounds, made some years ago by Wöhler and Buff, they obtained, by passing hydrochloric acid gas over crystallized silicon heated to a temperature just below redness, a very volatile liquid, boiling at 42° C. and yielding an inflammable vapor. This liquid was decomposed by water, with the production of a white substance, differing entirely from silica in its properties. To the volatile liquid these chemists gave the formula Si_2Cl_3+2HCl; and to the white body the corresponding formula Si_2O_3+2HO, $(Si=21)$.* More recently, however, Wöhler assigned to these bodies the formulæ $Si_6H_4Cl_{10}$ and $Si_6H_4O_{10}$ respectively† $(Si=14.)$ The authors observe that the above compounds may not have been absolutely pure when analyzed, and call upon chemists having more leisure to re-examine the whole subject.

This investigation has been undertaken by Friedel and Ladenburg. In the first place, they thought it improbable from theoretical considerations, that so volatile a body as the above chlorid should have so complicated a molecule; and from its method of preparation they inferred that

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* Ann. Ch. Pharm., civ, 94. This Journal, II, xxv, 270, 1858.

† Ib., cxxvii, 257. This Journal, II, xxxvii, 120, 1864.

it might be silicic chlorid, in which an atom of hydrogen had replaced one of chlorine. If they could not separate the body in question from the silicic chlorid formed at the same time, by fractional distillation, they were prepared to convert both into ethers and thus to effect the separation.

The compound was prepared by Wöhler and Buff's method. And they found that by subjecting the crude material to a series of careful fractionings, a liquid was obtained whose boiling point was 34° C. instead of 42°, and which distilled entirely between 34° C. and 37·5°. As thus purified, the liquid possessed all the properties mentioned by Wöhler and Buff. Its vapor mixed with air detonated violently in contact with flame, giving a white cloud of silica. It was analyzed by placing a weighed quantity in a sealed bulb, introducing this into a tube containing dilute ammonia, sealing the tube, and breaking the bulb. After a short time the tube was opened, its contents poured into a platinum dish and evaporated to dryness on the water-bath. The residue was treated with water, filtered, ignited and weighed; and by subtracting from the entire weight, that of the glass of the bulb, that of the silica was obtained. In the filtrate the chlorine was determined as usual. The results lead to the formula $\mathrm{SiCl_3H}$, $(\mathrm{Si}=28.)$ That this formula moreover, represents the size of the molecule was proved by the vapor density; experiment giving 4·64, while theory requires 4·69. The hypothesis of its composition is thus confirmed; and they showed farther that at ordinary temperatures chlorine transforms it into silicic chlorid, $\mathrm{SiCl_4}$; while at a red heat hydrogen acts upon $\mathrm{SiCl_4}$, converting a portion of it into $\mathrm{SiCl_3H}$.

When this substance is mixed with absolute alcohol, a large quantity of hydrochloric acid gas is evolved, and the resulting liquid, when subjected to fractional distillation, yields two bodies, one of which boils between 134° and 137°, and the other at 165° C. The latter body is silicic ether; the former is an ether corresponding to the chlorid above described. Its analysis gives the formula $\mathrm{Si}\text{Є}_6\mathrm{H}_{16}\Theta_3$, from which the authors derive the constitutional formula $\left.\begin{matrix}(\mathrm{SiH})'''\\(\text{Є}_2\mathrm{H}_5)_3\end{matrix}\right\}\Theta_3$. When silicic chlorid $\mathrm{SiCl_4}$ acts upon alcohol, it produces silicic ether $\left.\begin{matrix}\mathrm{Si}\\(\text{Є}_2\mathrm{H}_5)_4\end{matrix}\right\}\Theta_4$, as is well known; consequently the new ether bears the same relation to the volatile chlorid, that silicic ether bears to silicic chlorid. It is a limpid liquid, with an agreeable odor, and insoluble in water, by which it is slowly decomposed. It is rather more inflammable than silicic ether, and differs from it by evolving hydrogen when treated with an alcoholic solution of ammonia.

The action of sodium upon this ether is quite remarkable. When first introduced, a slight evolution of gas is perceived, due probably to the trace of alcohol present, produced by the action of atmospheric moisture on the chlorid. But if the mixture be gently heated, there is a uniform evolution of gas which upon examination proved to be pure hydric silicid or siliciuretted hydrogen. After allowing the first portions of the gas to escape, it may be collected for analysis. This was effected by placing a measured quantity in a graduated bell over mercury, and then passing up a concentrated solution of potash. The evolution of gas commenced at once; and, when the action ceased the volume was measured. It was found to occupy four times the volume of the original gas, and to burn with the pale flame characteristic of hydrogen. The action of the potash then is as follows: $(\mathrm{HK\Theta})_4+\mathrm{SiH}_4=\mathrm{K}_4\mathrm{Si\Theta}_4+\mathrm{H}_8$, from which it appears that one half the hydrogen comes from the potassic hydrate, the other half from the silicid. As 2 vols. of the latter increase to 8 vols. in the above experiment, they evidently furnish 4 vols. of hydrogen; and since an atom of hydrogen occupies one volume, and a molecule of silicid 2 volumes, it is evident that each molecule of the latter contains 4 hydrogen atoms, and that its formula is SiH_4. This is the formula assigned to it by Wöhler and Buff, its original discoverers; though they never obtained it pure, but always mixed with free hydrogen. The liquid which results from the action of the sodium, is pure ethylic silicate. The sodium appears to take no part in the reaction, since it remains white and metallic, and does not diminish in weight. The formation of the hydric silicid may therefore be thus represented:

$$\left(\left.\begin{matrix}(\mathrm{SiH})'''\\(\text{Є}_2\mathrm{H}_5)_3\end{matrix}\right\}\Theta_3\right)_4=\mathrm{SiH}_4+\left(\left.\begin{matrix}\mathrm{Si}\\(\text{Є}_2\mathrm{H}_5)_4\end{matrix}\right\}\Theta_4\right)_3.$$

The gas thus obtained is not spontaneously inflammable, at the ordinary atmospheric temperature and pressure. But if into a small quantity of it confined in a tall jar over mercury,—so that the mercury column considerably lessens the pressure,—a few bubbles of air be passed, ignition takes place with deposition of silicon mixed with silica. In this respect the gas behaves like hydric phosphid; and the authors suggest that the hydrogen mixed with the SiH_4 of Wöhler and Buff, may be the cause of its spontaneous inflammability. A hot knife blade placed near the bubbles as they rise through the mercury, inflames them with a slight explosion.

Friedel and Ladenburg have also examined the white substance produced by the action of water on the inflammable chlorid. It was prepared by passing the vapor of this chlorid into water at zero. The product was washed with ice-cold water, dried, first in a vacuum over sulphuric acid, and then in an oil bath at 150° to 180° C. and analyzed. The results give the formula $\mathrm{Si}_2\mathrm{H}_2\Theta_3$, from which the authors derive the rational formula $\left.\begin{matrix}\mathrm{SiH\Theta}\\\mathrm{SiH\Theta}\end{matrix}\right\}\Theta$. Its production is expressed thus:

$$((\mathrm{SiH})\mathrm{Cl}_3)_2+(\mathrm{H}_2\Theta)_3=\left.\begin{matrix}\mathrm{SiH\Theta}\\\mathrm{SiH\Theta}\end{matrix}\right\}\Theta+(\mathrm{HCl})_6.$$

These researches confirm the opinion originally advanced by Wöhler that these compounds are analogous to organic bodies, and consequently prove the analogy of silicon and carbon. It will be noticed that the inflammable chlorid $(\mathrm{SiH})\mathrm{Cl}_3$ is similar to chloroform $(\text{Є}\mathrm{H})\mathrm{Cl}_3$; that the compound $\left.\begin{matrix}(\mathrm{SiH})'''\\(\text{Є}_2\mathrm{H}_5)_3\end{matrix}\right\}\Theta_3$ corresponds precisely to the tribasic formic ether of Kay $\left.\begin{matrix}(\text{Є}\mathrm{H})'''\\(\text{Є}_2\mathrm{H}_5)_3\end{matrix}\right\}\Theta_3$; that hydric silicid SiH_4, is analogous to hydric carbid $\text{Є}\mathrm{H}_4$; and that the body $\left.\begin{matrix}\mathrm{SiH\Theta}\\\mathrm{SiH\Theta}\end{matrix}\right\}\Theta$ is identical in structure with formic anhydrid $\left.\begin{matrix}\text{Є}\mathrm{H\Theta}\\\text{Є}\mathrm{H\Theta}\end{matrix}\right\}\Theta$. For this reason, Friedel and Ladenburg propose the name *silici-chloroform* for the first substance, *tribasic siliciformic ether* for the second, and *silici-formic anhydrid* for the last. The quadrivalence of silicon seems therefore as firmly established as that of carbon itself.—*Bull. Soc. Ch.*, II, vii, 322, April, 1867.

6. *Crystallization of graphitoidal silicon.*—Professor W. H. Miller has examined some crystals of graphitoidal silicon, so called, which were received from Dr. Percy. They appeared to be oblique; but on measurement, they were found to be regular octahedrons, in which two parallel faces were much larger than the others; two other parallel faces were either too small to be observed or were altogether wanting. One of these scales had the faces of a twin octahedron. He concludes therefore, that there is no crystallographic reason for separating the graphitoidal from the ordinary octahedral variety of silicon.

He also considers it probable that graphitoidal boron, recently shown by Wöhler and Deville to be an aluminic borid, is tetragonal, as Sella has shown the adamantine boron to be. Sella views even the latter variety as a definite compound of boron with aluminum and carbon, mechanically mixed with pure boron.—*Phil. Mag.*, IV, xxxi, 397, May, 1866.

7. *Density of Ozone.*—At the meeting of the French Academy on the 6th of May, Regnault communicated a note from Soret of Geneva, upon the density of ozone. As previously determined by this chemist, the density of this substance obtained in absorption experiments, is one and a half times that of oxygen. He has now re-determined it by means of Graham's law of diffusion; i. e., the velocity of diffusion of a gas is inversely as the square root of its density. He ascertained the coefficient of diffusion of chlorine into oxygen and of ozone into oxygen. He found that in 45 minutes, for every cubic centimeter of chlorine contained in one of the two diffusion tubes, 0·227 of chlorine diffused into the upper tube, while for ozone, the quantity under the same circumstances was 0·271. Now the ratio $\cdot227:271=\cdot8382:1$; and if we assume ozone to have one and a half times the density of oxygen, Graham's law would give us $\sqrt{35\cdot5}:\sqrt{24}=1:\cdot8222$, a remarkably close approximation, considering the difficulties of the method. We may therefore fairly regard the density of ozone as one and a half times that of oxygen; or 1·657 if air be taken as 1, and 24 if hydrogen be unity. While therefore the molecule of free oxygen contains two atoms, that of ozone contains three.—*The Laboratory*, i, 121, May 18, 1867.

9. *Adamantine anthracitic carbon.*—In the name of M. le Comte de Douhet, Dumas presented recently to the Academy of Sciences at Paris some nodules of mineral carbon, remarkable for their hardness. They were found by Douhet in the hands of a merchant, who supposed them to come from Brazil, but their origin and mode of occurrence are not certainly known. These nodules consist of irregularly concentric layers. When cut and polished on the lapidary's wheel, they acquire a surprising luster. Even in the thinnest fragments the mineral is opaque. Its density is 1·66. A preliminary analysis by Friedel showed the presence of 11 per cent of ash; thus raising the question whether the hardness is not due to foreign impurities. Dumas therefore examined purer fragments, and found the quantity of ash 4 per cent in two specimens; one being the crude material, the other the same after pulverization and washing. Hence the ash is uniformly distributed through the mass. Moreover this ash is neutral in its reactions, and neither scratches nor abrades glass. Two elementary analyses gave Dumas, as a mean, the following composition: carbon 97·5, hydrogen 0·5, oxygen 1·5, ash 0·5=100.

This it will be noticed is the composition of anthracite. In a subsequent letter to Les Mondes, M. le Comte de Douhet, thus describes the mineral: The nodules are globular, mammillated, consisting of concentric layers, and occasionally possessing a nearly perfect cleavage. Though fragile and brittle, the fragments will scratch not only the hardest gems, but also the diamond itself; though ordinary anthracite will not scratch even glass. When facets are cut upon it, this singular mineral refracts and disperses light with that white luster which is characteristic of the diamond; other and colored gems reflect light tinged with color; while the brilliance of the diamond is always white, even when it is itself colored. Prismatic colors appear only when the light is refracted in the interior of the crystal. This mineral, being opaque, cannot decompose light, though it actively disperses it. These properties of hardness and luster contrast strangely with the feeble density, anthracitic appearance, and composition of this substance.

At the next session of the Academy, Dumas read a note from Mène, calling attention to some specimens of carbon presenting a similar appearance, which he had obtained artificially by heating in the muffle of a cupel furnace for a long time the anthracite coal of Creuzot. It thus acquires a metallic luster, steel-gray color, and scratches glass and steel with the cry of the diamond. Its density is 1·637, and its composition is carbon 96·8, volatile matter 1·0, ash 2·2=100. Mène also states that the coke produced from a mixture of the Creuzot anthracite with the St. Etienne bituminous, contains a multitude of brilliant points which readily scratch glass.—*Comptes Rendus*, lxiv, 547 and 674; *Les Mondes*, Apr. 11, 1867.

10. *On the origin of meteorites.*—In his researches on diffusion, GRAHAM has shown that certain metals, such as iron, platinum, and gold, which occur native in the soft colloid condition, readily absorb or occlude gases. Hence by examination of the gases evolved from a meteorite for example, the character of the atmosphere through which the ignited mass has passed, may be determined. The well known Lenarto meteorite is admirably adapted for such an experiment, being very pure and soft. A piece 50 millimeters long, 13 wide and 10 thick, was cut from the mass, cleansed and placed in a porcelain tube connected with a Sprengel aspirator. The tube was then heated in an ordinary combustion furnace by ignited charcoal. Gas was freely evolved, which in 2½ hours amounted to 16·53 cubic centimeters. This gas burned like hydrogen, and when analyzed gave 85·68 hydrogen, 4·46 carbonic oxyd, 9·86 nitrogen in the 100. As the volume of the iron was 5·78 c.c., it appears to yield 2·85 times its volume of gas, of which 86 per cent is hydrogen. Now, since hydrogen has been shown by spectrum analysis to be present in the fixed stars, and by Secchi to be a principal element in some of them, we may fairly suppose that the Lenarto meteorite has brought to us the hydrogen of those distant bodies. Moreover it is found that malleable iron can scarcely be made to occlude more than its own volume of hydrogen under the ordinary atmospheric pressure. But the meteorite gave three times this quantity. Hence Graham infers that it must have originated beyond the limits of the light cometary matter of our solar system.—*Chem. News*, May 31, 1867.

11. *Action of manganic peroxyd on uric acid.*—C. Gilbert Wheeler finds that when uric acid is warmed with water and manganic peroxyd, and sulphuric acid added in small portions, so long as any action is observed, the filtrate yields on concentration, crystals of parabanic acid. But that if the mixture of water and uric acid be treated with the peroxyd so long as carbonic dioxyd is evolved, and the whole filtered, manganic oxalate is left on the filter, and the filtrate contains allantoin and urea. He gives the reaction as follows: $(\text{Є}_5\text{H}_4\text{N}_4\Theta_3)_3+(\text{Mn}\Theta_2)_3+(\text{H}_2\Theta)_4=(\text{Є}_4\text{H}_6\text{N}_4\Theta_3)_2+(\text{Є}\Theta\text{H}_4\text{N}_2)_2+(\text{Mn}\text{Є}_2\Theta_4)_2+\text{Mn}\text{Є}\Theta_3$.—*From the author's paper in the Zeitschrift für Chemie.*

12. *Indium.*—Fremy exhibited to the Academy on the 22nd of April, in behalf of Professor Richter who was present, two ingots of indium obtained from the Freiberg blendes, which were about a decimeter high, and a few centimeters in diameter, and weighed 500 grams. They were valued at 20,000f.

13. *Expansion of metals and alloys by heat.*—A. Matthiessen has applied the hydrostatic method—by means of which he determined the expansion of water and mercury (see this Journal, II, xliii, 254)—to metals and alloys. The unit of volume at 0° C. becomes at t° C.,

$$V_t=1+\frac{a}{10000}t+\frac{b}{1000000}t^2,$$

and is at 100° C. equal to $1+c$. The values of a, b, and c determined by him are as follows:

	a.	*b.*	*c.*
Cadmium,	0·8078	0·140	0·009478
Zinc,	·8222	·070	8928
Lead,	·8177	·0222	8399
Tin,	·6100	·0789	6889
Silver,	·5426	·0405	5831
Copper,	·4443	·0555	4998
Gold,	·4075	·0336	4411
Bismuth,	·3502	·0446	3948
Palladium,	·3032	·0280	3312
Antimony,	·2770	·0397	3167
Platinum,	·2554	·0104	2658

He investigated the following 19 alloys: 1. Sn_4Pb; 2. Pb_4Sn; 3. CdPb; 4. Sn_4Zn; 5. Sn_6Zn; 6. Bi_{44}Sn; 7. BiSn_2; 8. Bi_{24}Pb; 9. BiPb_2; 10. Cu+(33·85 vol.) Zn; 11. AuSn_2; 12. Au_2Sn_7; 13. Ag_4Au; 14. AgAu; 15. AgAu_4; 16. Ag+(19·65 vol.) Pt; 17. Cu+(48·06 vol.) Au; 18. Cu+(28·31 vol.) Ag; 19. Cu+(73·13 vol.) Ag.

The volume at 100° C. was determined as above and also calculated from that of the component metals; he obtained also the specific gravity, and in an earlier investigation the electric conductibility. The results thus obtained are:

No. of Alloy.	Volume at 100° C.		Specific gravity.		Conductibility.	
	Observed.	Calculated.	Observ.	Calc.	Observ.	Calc.
1.	1·007188	1·007225	8·188	8·203	10·57	10·63
2.	8419	8129	10·590	10·645	8·28	8·43
3.	9138	8847	10·246	10·246	12·61	13·72
4.	7184	7144	....	....	13·22	13·45
5.	7058	7066	....	....	12·66	12·84

No. of Alloy.	Volume at 100° C.		Specific gravity.		Conductibility.	
	Observed.	Calculated.	Observ.	Calc.	Observ.	Calc.
6.	4064	3972	9·803	9·801	0·245	1·28
7.	5098	5207	8·772	8·738	3·96	5·59
8.	4086	4026	9·845	9·850	0·257	1·30
9.	8621	6007	10·956	10·541	2·09	4·23
10.	5719	6328	....	....	21·71	70·20
11.	4233	5919	11·833	11·978	14·27	35·51
12.	4428	6223	....	....	6·00	28·25
13.	5166	5549	12·257	12·215	20·93	94·62
14.	4916	5123	14·870	14·847	14·59	86·52
15.	4300	4693	17·540	17·493	20·91	78·38
16.	4568	5207	....	....	6·70	83·60
17.	4657	4716	....	....	12·00	83·25
18.	5436	5233	....	....	67·85	95·00
19.	5713	5607	....	....	63·00	98·20

The volume at 0° C. being 1. From these tables Matthiessen concludes that the volume (as well as the specific gravity) of any alloy between 0° and 100° C. nearly equals the mean of the volumes of the alloyed metals at the given temperature. In other words, neither volume nor specific gravity depends on the *chemical* nature of the alloy; while the last two columns show that the electric conductibility, not being simply the calculated mean, does depend on the chemical condition of the alloy. In his concluding remarks, Matthiessen states that he is able to calculate the conductibility of any alloy if it be considered as a "solidified solution of one metal in the other."—*Pogg. Annalen*, 1867, cxxx, 50–76; *Cosmos*, 1867, v, 160. G. H.

14. *Undulatory theory of heat.*—Babinet says that his theory, first published in 1838 is still new; we give the following extract from L'Institut, 1866, pp. 340–342.

The heat of a molecule is its vis-viva; two molecules are in caloric equilibrium when they possess the same vis-viva. In this condition they will, either at a distance or in contact exchange equal quantities of heat, and if placed in the same sphere, they will produce the same radiation.

If Θ represents the mass of a molecule of oxygen having a velocity v, and H and v', the same quantities for hydrogen; then these molecules have the same quantity of heat and the same temperature if

$$\Theta v^2 = \mathrm{H} v'^2.$$

As $\Theta = 16\mathrm{H}$, we have $v' = 4v$.

For any two atoms m and m' with the velocities v and v' we have likewise

$$mv^2 = m'v'^2.$$

At any other temperature these atoms are still in equilibrium if their new velocities of vibration u and u' fulfill

$$mu^2 = m'u'^2.$$

Consequently $mv^2 - mu^2 = m'v'^2 - m'u'^2$.

That is, the two atoms gain or lose the same quantities of heat between two given temperatures. Or in other words, *the specific heat of elementary atoms is constant,* which is the law of Dulong and Petit.

According to Babinet, all molecules, vibrating separately, have the same vis-viva and heat, independent of the state of aggregation of the body (solid, liquid or gaseous). Hence the *unit of heat*—or one *dynamic calory*—is the excess of vis-viva of any molecule at 1° C. above that which it has at 0° C. At this temperature, 0°, the total quantity of vis-viva of the molecule is very nearly 1200 such units.

By *combining* two molecules so that they vibrate as one, Babinet proves that their vis-viva will be doubled; or if the final temperature is to be the original temperature, the combination must lose a vis-viva equal to that originally possessed by each of the molecules, or 1200 dynamic calories (?).

The demonstration of the law of Dulong and Petit is favorable to the peculiar views of Babinet; but we must await further developments before we can form an intelligent opinion concerning the other parts of his paper. G. H.

15. *Action of heat on the optical properties of crystals.*—DesCloizeaux has determined optically the system of crystallization for quite a number of minerals, hitherto imperfectly ascertained, and has also made some very important observations on the variation of the optical properties of crystals by heat. He finds:

(1.) On the optical properties of *uniaxial* crystals heat seems to have no influence. Crystals which, by some irregularity of structure, show an open cross (croix disloquée) resembling the hyperbolic branches of biaxial crystals, did not show any variation even by a change in temperature from 10° to 190° C. Anatase, apophyllite, beryl, idocrase, tourmaline, were among the crystals examined.

(2.) In *biaxial* crystals the apparent distance of the axes is generally changed by a change of temperature; so that the three indices of refraction are probably unequally modified by heat. Fizeau has shown by direct determinations that the indices of refraction of the ordinary and extraordinary rays in uniaxial calcite and quartz are thus unequally modified by heat. The amount of displacement of the axes, as well as the dispersion, are very different for different substances, but have not as yet been found related to other optical properties. DesCloizeaux found among 72 orthorhombic crystals—

		Displacement.	Dispersion.
19	showed	great,	great.
10	"	feeble,	considerable.
4	"	insensible,	considerable.
10	"	considerable,	feeble.
12	"	feeble,	very small.
17	"	insensible or uncertain,	very feeble or nearly zero.

Aragonite and the micas show exceedingly small variation. Celestine (increase of 6° 41′ between 10° and 105° C.) and leadhillite (diminution of 16° 50′ between 15° and 180°) are among the more variable.

(3.) While in the orthorhombic forms the median line of the optical axes remains unchanged, *it does change in most monoclinic crystals*, as already found by Neumann, in 1835, for gypsum. Among 22 such crystals with the optical axes in the plane of symmetry, and heated between 15° and 200° DesCloizeaux found that 11 showed a considerable, 6 showed a feeble or hardly sensible, 5 showed hardly any change in the median line.

(4.) The five triclinic minerals investigated (albite, amblygonite, axinite, disthene, sassoline) showed between 15° and 175° C. hardly any change in either the distance or the plane of their optical axes.—*L'Institut*, 1866, pp. 139–141. G. H.

16. *On the determination of atomic weights by optical means;* by Dr. Albrecht Schrauf.—If μ be the index of refraction and d the density of a body, then Newton's formula for the *refractive power* M of any substance is by Schrauf replaced by

$$\mathrm{M}=\frac{\mathrm{A}^2-1}{d},\qquad \mathrm{N}=\frac{\mathrm{B}}{d^2},\qquad \mu=\mathrm{A}+\frac{\mathrm{B}}{\lambda^2},$$

where λ is the wave-length, N the *dispersing power.*

Schrauf modifies the latter equation of Cauchy to $\mu=1+\frac{\mathrm{C}'}{\lambda^2}$,

where C′ is a constant, and uses A as the numerical value of μ for $\lambda=\lambda_\varrho$, the wave-length of the red rays. For the correctness of this modified relation between μ and λ he gives good theoretical and experimental proof.

If P be the atomic weight of an element, then $\mathbf{M}=\mathrm{PM}$ and $\mathbf{N}=\mathrm{PN}$ are respectively what he calls the *refraction-* and *dispersion-equivalents.* Moreover, by considering light to be a vibratory motion of the atoms, he deduces

$$\mathbf{M} \text{ proportional to ZG},$$

where Z is the number and G the magnitude of the "physical atoms."

$\mathbf{M}$ of any element he determines by μ in the different conditions of aggregation, and also indirectly from the several compounds it forms. In the latter case he subtracts $\mathbf{M}$ (Pars) or the refraction-equivalent of the other parts from that of the substance entire, $\mathbf{M}$ (Tot);

$$\mathbf{M}\,(x)=\mathbf{M}\,(\mathrm{Tot})-\mathbf{M}\,(\mathrm{Pars}).$$

For any compound of a, b, c, etc., he puts

$$\mathbf{M}(a+b+c+\ldots)=n\mathbf{M}(a)+n'\mathbf{M}(b)+\text{ etc.},$$

where n, n' . . . are simple, entire numbers.

The following is a synopsis of the principal results. P are the *atomic* weights as now adopted.

Elements uncombined; μ directly determined.

Gas:	Hydrogen,	M=0·004050	$\mathbf{M}$=0·004050
	Oxygen,	0·000489	0·007824
	Nitrogen,	0·000602	0·008428
	Chlorine,	0·000627	0·022258
Liquid or solid:			
	Sulphur,	0·002044	0·065144
	Carbon, diamond,	0·001810	0·021720 etc.
μ determined by Brewster's law of polarization.			
	Antimony,	0·002545	0·30540
	Silver,	0·001262	0·13631
	Mercury,	0·001987	0·39740 etc.

Elements in combination:

Butyl-alcohol	$Ꞓ_4\mathrm{H}_{10}\Theta=74$,	M=0·001474,	$\mathbf{M}$=0·109063
Ethyl-ether	$Ꞓ_4\mathrm{H}_{10}\Theta=74$	0·001453	0·10757

Taking Θ as the part, and $x=Ꞓ_4\mathrm{H}_{10}$, the above-stated value of $\mathbf{M}(\Theta)$ gives

$$\mathbf{M}(Ꞓ_4\mathrm{H}_{10}=\mathbf{M}(\mathrm{tot.})-\mathbf{M}(\mathrm{pars})=0{\cdot}100521.$$

By means of this value he now from mercury-ethyl, $Ꞓ_4\mathrm{H}_{10}\mathrm{Hg}$, calculates $\mathbf{M}(\mathrm{Hg})=0{\cdot}07598$, while direct determination from vapor gave

0·031800, and by means of Cauchy's formula for reflection from metals 0·021720, while by Brewster's formula 0·39740 was obtained. In this manner he determines the equivalent for quite a number of elements.

For easier comparison the refraction equivalents are referred to that of hydrogen as unity. These values he marks [**M**], hence for reduction

$$\mathbf{M}(\mathrm{H}) : [\mathbf{M}(\mathrm{H})] = 0{\cdot}004050 : 1{\cdot}00.$$

Further he deduces from these latter values the *optical atomic numbers*, that of hydrogen being 100, by the equation

$$\mathrm{ZG} = \frac{100}{\mathrm{P}} [\mathbf{M}].$$

We condense Schrauf's tables into the following, giving the values of the atomic weight P (H=1), the refraction-equivalent [**M**] (also for H=1) and the optical atomic number ZG (that of H equal to 100). The last two refer to the *red* rays. The metallic, solid-liquid and gaseous states are indicated respectively by *m*, *f* (fest-flüssig) and *g*.*

	P		[**M**]	ZG		P		[**M**]	ZG
Hydrogen	1	*g*	1·00	100·00	Na	22	*f*	3·68	15·96
Al	27·4	*f*	5·79	21·14	P	31	*g*	4·81	15·51
Sb	120	*m*	75·59	62·99			*f*	18·70	60·31
As	75	*g*	4·05	5·23	Hg	200	*g*	7·87	3·83
		f	12·07	16·01			*f*	18·81	9·40†
Ba	137	*f*	11·38	8·30			*m*	98·38	49·19
Be	9·4	*f*	4·01	42·66	O	16	*g*	1·97	12·25
Pb	208	*f*	27·02	12·99	S	32	*g*	3·94	12·00
		m	88·60	42·60			*f*	16·13	50·40
Bo	22	*f*	9·18	41·71	Se	79·5	*m*	29·81	37·77
Br	80	*f*	10·76	13·45	Ag	108	*f*	9·08	8·40
Ca	40	*f*	6·65	16 65			*m*	33·75	31·25
Cd	112	*f*	11·61	10·38	Si	28	*f*	8·73	31·17
Cl	35·5	*g*	5·51	15·53		?	*m*	32·45	115·00
Fe	56	*m*	33·56	51·00	N	14	*g*	2·09	14·93
F	19	*f*	1·45	7·63	Sr	87·6	*f*	8·93	10·19
I	127	*f*	19·05	15·00	Ti	56	*f*	31·67	56·55
K	39·2	*f*	4·73	12·06	Bi	210	*f*	26·90	12·80
C	12	*f*	5·01	41·75			*m*	80·82	38·49
Cu	63·4	*f*	9·60	15·15	W	184	*f*	26·66	14·49
		m	17·83	27·05	Zn	65·2	*f*	7·23	10·93
Li	7	*f*	3·36	48·00			*m*	21·01	32·22
Mg	24	*f*	7·74	32·25	Sn	118	*f*	19·70	16·70
Mo	96	*f*	48·73	50·76	Zr	44·8	*f*	19·01	42·42

From this table Schrauf deduces further that the various conditions of the same elements are optically expressed in simple multiples. Thus for **S** as solid we have 16·13, which is 4 times 4·03, almost identical with 3·94 for sulphur vapor. Also that allied elements are optically in the same relation of simple multiples; thus the last column gives

F 7·63 (*f*), Br 13·45 (*f*), I 15·00 (*f*); Cl 15·53, *g*.
Θ 12·25 *g*; **S** 12·00 (*g*), **Se** (*m*) 37·77; **S** (*f*) 50·40;

so also N, As, P, Sb, Br, and other groups.

Though many points are yet obscure, we nevertheless hail this investigation of Schrauf as a decided progress.—*Ber. Ak. Wien*, lii, 176–211, 1865; *Pogg. Ann.*, cxxvii, 175–176, 1866. G. H.

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* The symbols in the table, although none are written with barred letters, stand for the equivalents as adopted in the new system.

† By Cauchy's formula 8·96 and 4·48.

II. MINERALOGY AND GEOLOGY.

1. *Altitudes in British America.*—The following altitudes and localities of peaks, passes and stations in the Rocky Mountains in British America are compiled from the reports and maps of Capt. Palliser's explorations, published by Parliament, 1859–'65, and are given here for convenient reference. Some of the locations are taken from the observations published in the reports, others from the maps. When there is any discrepancy between the localities which have their latitudes and longitudes given in the earlier reports, and the maps, the latter have been followed, as they are the latest publications, and therefore may be inferred to be the more correct.

The altitudes are deduced from barometrical observations (aneroid), and the temperatures of boiling water.

	Latitude, North.	Longitude, West.	Altitude above sea.
	° ′	° ′	feet.
South Kootanie Pass,	49 10	114 55	6,030
British Kootanie Pass,	49 20	114 58	6,300
Kananaskis Pass,	50 40	115 25	5,700
Vermillion Pass,	51 12	116 10	4,903
Kicking-horse Pass,	51 24	117 25	5,210
Bow river Pass,	51 40	117	6,347
Pipe-stone river Pass,	51 40	116 30	7,200
Howe's Pass,	51 45	117 20	5,400
Otter Lake (source of the Columbia river),	50 07	116 5	3,090
Kootanie Trading Post (U. S.),	48 56	115	2,300
Fort Colville (U. S.),	48 38	118 3	1,050
Mt. Murchison,	51 47	117	13,500
Mt. Forbes,	51 45	117 36	13,400
Sullivan's Peak,	50 52	117 50	7,858
Mt. Tekarra,	52 50	118 40	
Mt. Brown,	52 28	118 25	
Mt. Hooker,	52 17	118 12	
Mt. Balfour,	51 35	117 10	
Mt. Vaux,	51 20	116 45	
Mt. Robinson,	50 52	115 27	
Mt. Head,	50 24	115	
Fort Carleton,	52 52	106 16	1,321
Fort Edmonton,	53 31	113 15	2,088
Old Bow Fort,	51 9	115 4	3,963
Rocky Mountain House,	52 40	115 10	3,195
Jasper House,	53 12	118 10	

"Kicking-horse Pass" is given here as located on the map; in the earliest report it is stated as long. 117° 20′ W., and alt. 5210 ft. (Rep. 1859, p. 38.)

Except Mt. Murchison, the heights named here are along the crest (watershed) of the Rocky Mountains; the names of other peaks were not added to this list, as no measurements are given. Mts. Brown and Hooker were stated by Douglass, many years ago, to be over 15,000 feet high, and on the map accompanying Sir Wm. Hooker's "*Flora Boreali-Americana*" (1840), Mt. Brown is stated to be 16,000 feet high, and Mt. Hooker 15,700 feet. In the first of Capt. Palliser's Reports (1859,

p. 39) he states of Mt. Murchison that "it is a most massive mountain, which the Indians consider to be the highest of all the Rocky Mountains. I afterward measured two of its highest peaks." * * "They are respectively 15,789 and 14,431 feet above the sea." This was written, however, at Fort Edmonton in Oct. 1858, and on the maps published in 1865, the altitude is given as tabulated above, 13,400 feet, probably as the result of later computations.

In the later and fuller Journal (1863, p. 112) speaking of it, he says, "if a rough triangulation I made of what I supposed to be the same peak from the Kootanie Plain, is to be trusted, it must be 13,000 to 14,000 feet above the sea. The average altitude of the mountains is 11,000 to 12,000 feet above the sea, and I do not place much reliance on estimates of altitudes greater than that, as there is a striking appearance of uniformity in the altitude of the mountains."

In this great mountain mass in which these peaks are, between lat. 51° and 53°, and long. 116° and 119°, the report speaks much of glaciers. About Mts. Lyell and Murchison especially they are on a grand scale, and descend into some of the valleys to an altitude of 4,320 feet above the sea, and fill great valleys above that altitude. All the conditions requisite for producing glaciers of great magnitude are stated to exist.

W. H. B.

2. *On some remains of Paleozoic Insects recently discovered in Nova Scotia and New Brunswick*; by J. W. Dawson, LL.D.—Dr. Dawson has communicated to us a paper with the above title from which we cite the following facts. Mr. James Barnes of Halifax has discovered in the shale of the coal formation, Little Glace Bay, Cape Breton, a wing of a Neuropter, whose full expanse of wing when alive must have been *seven inches.* Mr. Scudder has named it *Haplophebium Barnesii*, and pronounces it an *Ephemerina.* This is the second species thus far discovered in the Nova Scotia coal formation, the only other having been found by Dr. Dawson some years since in a Sigillaria stump, at the Joggins.

The remains of the Devonian insects described are the wings of four species found by Mr. C. F. Hartt in the plant-bearing Devonian shales of St. John, New Brunswick, probably equivalents of the Hamilton or Chemung formations of New York. The species are *Platephemera antiqua* Scudder, of the *Ephemerina; Homothetus fossilis* Scudder, intermediate between the *Odontata* and *Sialina; Lithentomum Harttii* Scudder, approaching somewhat the *Hemeristina* of Illinois; *Xenoneura antiquorum* Scudder, another Neuropter, but the specimen is too imperfect to determine from it the family. Descriptions and wood-cuts of the wings by Mr. Scudder are given in the paper, which is to form part of the new edition of Dr. Dawson's Acadian Geology.

3. *A Monograph of the British Fossil Crustacea belonging to the order Merostomata*, Part I, *Pterygotus Anglicus*; by Henry Woodward, F.G.S., F.Z.S., of the British Museum. 44 pp. 4to, with 9 plates. From the publications of the Palæontographical Society, volume for 1865. London, 1866.—The Crustacean here described, from remains found in the lower Old Red Sandstone in Perthshire and Forfarshire, is one of the most remarkable fossils of the Paleozoic. As the author observes, the genus Pterygotus contains probably the largest species of the whole

Crustacean class. Four nearly entire bodies have been found, the largest about four feet long and fifteen inches broad, but with the head wanting. The memoir of Mr. Woodward is very full in its descriptions and its synonymy and references, and its illustrations are of natural size. The memoir opens with a table giving the arrangement and nomenclature of the segments of the Crustacea with their appendages; remarks on the classification of the order Merostomata; a table showing the geological range and geographical distribution of the species of the order; and the bibliography of the subject. Mr. Woodward has also published in the Quarterly Journal of the Geological Society for February, 1867, an illustrated paper on some points in the structure of the Xiphosura, having reference to their relationship with the Eurypteridæ.

4. *Observations on the Glacial Phenomena of Labrador and Maine, with a view of the recent Invertebrate Fauna of Labrador;* by A. S. PACKARD, Jr., M.D. Mem. Boston Soc. N. H., Vol. I. Published May, 1867. 92 pages quarto, with two plates.—In this important memoir the author brings together the evidence and materials bearing upon the nature of the marine deposits of the Post-tertiary or Drift period in Eastern North America. In the first part a description is given of the physical and geological features of eastern Labrador, with an account of the glacial phenomena which the author has observed there, and a catalogue of the fossils collected in the "Leda Clay" of Labrador and New Brunswick. This is followed by an account of the Glacial and Drift action in New England, with lists of the Leda Clay fossils from the various localities which have been examined.

The author recognizes four epochs or changes in physical conditions during the Post-tertiary or Quaternary Period. First, a period of elevation above the present sea level, accompanied by intense glacial action. Second, a period of subsidence, attended by an amelioration of the climate, during which the "Leda Clays" were deposited. Third, the *Period of raised Beaches*, during which the sea level was 500 or 600 feet higher than at present, while the climate had become warmer, allowing a northward migration of animals. Fourth, the *Terrace epoch*, during which the land was again elevated, causing the drainage of extensive estuaries and bays, and the formation of terraces.

From the character of the fossils of the Leda Clays at various localities it is shown that during this period the marine animals of the coast were distributed after nearly the same plan as at present, except that the Arctic and Sub-arctic faunæ descended a little farther along the coast, while the Virginian fauna even extended north of Cape Cod, its present limit,—the fossil shells of Point Shirley, Mass., agreeing with the existing species of Long Island Sound. At that period the Bison and the Walrus lived together in Maine, which had a marine fauna resembling that now found in Labrador and Newfoundland. The evidence is entirely opposed to the theory of a Tertiary or Post-tertiary connection of the land between Europe and America, and to any interchange of species either of animals or plants,—those that are common to the two continents being regarded as circumpolar species, which have descended to a greater or less extent on each continent during the cold period, and retreated or perished, more or less completely, during the subsequent warmer period. No change of importance in the flow of the Gulf Stream could have occurred, as shown by the fossils of Point Shirley and Nantucket, but the arctic current swept more strongly against the coast of Maine and up the St. Lawrence river and Lake Champlain, and probably through the Bay of Fundy from the Gulf of St. Lawrence.

The second part of the paper is occupied by a Catalogue of the Marine Invertebrates of Labrador, in which a number of new species of Worms, Crustacea, and Mollusca are described. In the first part of the paper two new species of fossil shells are described from Labrador, viz., *Bela robusta* and *Fusus Labradorensis*, which, with numerous other interesting forms, are well figured. V.

5. *Exploring Expedition in the Interior Basin from Colorado west.*—The last Congress ordered an examination of a belt of territory on and near the 40th parallel of north latitude, between the meridians of 105° and 120° W., along and near the proposed route of the Pacific Rail Road. The survey is under the direction of the Secretary of War, or more immediately under Maj. Gen. A. A. Humphreys, chief of the U. S. Engineers, and Mr. Clarence King has been appointed to conduct the work, with the power to choose his own assistants. Mr. James T. Gardner is the first assistant in Topography, and Prof. James D. Hague in Geology. The party will consist of about ten scientific men, a few camp men, and a sufficient military escort for protection. The topography and geology of the country will receive the greater share of attention, but the other departments of science will not be neglected. A botanist, a zoologist, and a photographer accompany the expedition. The party sailed early in May for San Francisco, and will commence work as soon as possible at or near Pyramid Lake, and then work eastward.

The belt to be examined commences at the boundary of California, and extends entirely across Nevada and Utah, and into Colorado, to the eastern base of the Rocky Mountains. It is expected that when completed, and taken in connection with the labors of the State Geological Survey of California, and the private explorations of Prof. Whitney and Baron Richtofen in Nevada, it will furnish a geological section entirely across the great mountain system of the western part of the continent, at its widest portion, and include an examination of the most important formations producing the precious metals in North America. It is purposed to devote at least three years to the field-work.

Annexed is a list of the scientific corps as at present organized: Clarence King, chief in charge; James T. Gardner, H. Custer, and F. A. Clarke, Topographical assistants; Prof. J. D. Hague, Arnold Hague, and Samuel F. Emmons, Geological assistants; W. W. Bailey, Botanist, Robert Ridgeway, Zoologist, and T. H. O'Sullivan, Photographer.

6. *Locality of Secondary Fossils in Oregon;* by W. P. BLAKE, in a note to Prof. DANA, of June 1, 1867.—In my recent tour through Oregon I obtained a very interesting suite of fossils from Mr. Congdon at the Dalles, who collected or received them from Beaver creek and Crooked river south of John Day's, Oregon. There are *Trigonias*, apparently two species; a *Pholadomya*, *Ammonites*, *Fusus*, *Dentalium*, and a *Turrilites*, all of them very perfect casts of the inner and outer portions of the shell. The Turrilite indicates the Cretaceous age of the formation, and it is

possible that the other fossils may be referred to the same era instead of the Jurassic.

7. *Exogenous leaves in the Cretaceous rocks of Iowa;* by C. A. White. From a letter to one of the editors, dated Nebraska City, June 6th, 1867.—While at Red Oak Junction, the county seat of Montgomery county, Mr. Meek found in the sandstone there, which I had called in my late article in the American Journal the "Nishnabotany sandstone," a couple of specimens of exogenous leaves which he says are identical with some of those described from the Lower Cretaceous of Nebraska. This is very satisfactory, since it confirms my previously expressed opinion; the place is the most southerly point at which undoubted Cretaceous rocks have been seen in Iowa.

8. *C. A. White on Drift Phenomena in S. W. Iowa.*—To the close of the first paragraph on page 303, vol. xliii, the following sentence should be added. "Sets No. 3 [on an accompanying map not published] represent a current coinciding quite nearly with the general direction of the drainage upon the western water-shed, and sets No. 1 and No. 2 represent currents approximately coinciding with the general courses of the Missouri and Platte rivers."

9. *On new localities of Diamonds in California.*—Prof. Silliman communicated through Mr. Goodyear the following facts to the Academy of Sciences of California at the meeting on May 7th. One diamond had been found in French Corral which weighed 5·114 grains (equal to 1⅛ carats). It was symmetrical in form and slightly yellow in color from being subjected to a fire test. It was found in the deep gravel washings. The second specimen was from Forest Hill, El Dorado (Placer?) county; weight 5·673 grains, equal to nearly 1½ carats; color good, but less perfect and symmetrical than the first. The third specimen was from Fiddletown, Amador county. It is smaller and less perfect than either of the others. Since 1855 five diamonds are known to have been found at Fiddletown, none weighing much over a carat. All were found in a gray, cemented gravel, underlying a stratum of lava or compact volcanic ashes. The fourth specimen was from Cherokee Flat, Butte county, which has acquired some reputation as a diamond locality. It has been cut and set in a ring.

10. *Note upon "Partzite;"* by Wm. P. Blake.—The silver ore from Blind Springs, Mono county, California, described by Mr. Arents as a new mineral under the name Partzite (this Jour., xliii, 362), appears to be a mechanical mixture without a definite chemical composition. It evidently results from the decomposition of the antimonial and plumbiferous silver ores in the upper portions of the veins of that region. Specimens which I obtained there last year exhibit a variety of colors, and I do not think that analyses of any two different samples would agree.

11. *Reliquiæ Aquitanicæ; being Contributions to the Archæology and Palæontology of Périgord and the adjoining provinces of Southern France;* by Edouard Lartet and Henry Christy. Edited by Thomas Rupert Jones, Prof. Geol., etc., Roy. Military College, Sandhurst. Part IV, March, 1867, pages 25–32, and 57–72, Plates A. xiii, xiv; B. vii–x. (London, H. Baillière; Baillière Bros., New York).—This new number of the Reliquiæ Aquitanicæ opens with a brief statement of the charac-

teristics of the Reindeer period, and next takes up the features and geology of the valley of the Vezère. We cite the following paragraphs from Mr. Christy's observations on the Reindeer period.

"It would be easy to cite many circumstances illustrative of the resemblance between the condition and habits of the modern Esquimaux and these cave-dwellers of France at the Reindeer-period. But now comes the great question, When was the Reindeer-period in Southern France? and what is its antiquity?

"It is far easier to indicate its place in the series of observed facts in relation to ancient Man, than to assign to it any definite antiquity of years. Geologically, a wide gulf separates it from the Drift-period, though perhaps wider in the geological than in the paleontological aspect; but, on the other hand, it will seem, both from the paleontological and archæological bearings, to be of higher antiquity than the Kjökkenmöddings of Denmark and the Lacustrine Dwellings of Switzerland, and very certainly than the whole group of so called Celtic and Cromlech remains. Comparing its fauna with that of these various periods, the Reindeer-period may be placed thus:—

"In the Drift (Valley-gravels) the Mammoth, Rhinoceros, Horse, and Ox are the predominant animals, and the Reindeer appears but sparingly. In the Dordogne Caves the Reindeer predominates, associated largely with the Horse and Aurochs, and exceptionally with some remains of Mammoth, Hyena, &c.; but all traces of such domesticated animals as the Sheep, the Goat, and the Dog are wanting.

"In the Kjökkenmöddings of Denmark, though so much nearer the Subarctic regions, the Reindeer is not found, and the fauna, though more ancient than that now existing, indicates the presence of domesticated animals (Dog).

"The same may be said of the Swiss Lacustrine Dwellings: domestic animals are present; and the Reindeer is absent even from the most ancient of them, though that it was once in the neighborhood is manifested by the existence of its remains in caves (at l'Echelle) in the same district.

"In none of the Cromlechs or Sepulchres is there a trace of the Reindeer; and the fauna indicated by the remains found in them is cited as more recent than either the fauna of the Kjökkenmöddings or that of the most ancient of the lake-dwellings.

"From the archæological or industrial point of view, it may be remarked that from the Drift we have no example of Man's industry except implements of flint; and of these only the larger and coarser have been detected, though there is no reason to doubt that he had also implements for finer work than the majority of those found are fitted for.

"In the Reindeer-period, although Man had attained to a great proficiency in chipping, we have a total absence of ground or polished axes; and though he had arrived at the art of sewing, there is no trace of his having known how to spin; and in many of these caves of Dordogne there are no traces of pottery.

"In the Kjökkenmöddings pottery is not unfrequent, though ground axes are very few, but not wholly wanting, and spindle-whorls are scarce.

"In the very oldest of the lake-dwellings (those in which there is no trace of metal, as at Wangen) the majority of the axes are ground, and the grinding-beds are the same as those found in the Surface-period of Denmark and England. Pottery is abundant; not only spinning but weaving is presented; and there are evidences that the cultivation of wheat and other cereals had been attained to. In the Cromlechs and the Sepulchres, pottery is abundant; and the frequent occurrence of articles in bronze indicates a later time.

12. *Manual of Geology;* by the Rev. SAMUEL HAUGHTON, M.D., F.R.S., Prof. Geol. Univ. of Dublin. 2nd ed., revised and considerably enlarged. 416 pp., 12mo. London, 1866. (Longmans, Green, Reader, and Dyer.)—Prof Haughton has aimed to present in his Manual the general results of geological investigation without many of its details. He commences at once with the origin of the globe, and presents deductions as to the successive steps of progress in its inorganic material and its life, throughout the history, illustrating this progress with many diagrams. While we could not subscribe to all of the deductions, thinking them often more positive than the facts warrant, we commend the book as one that will be read with profit. But it appears to us better for the teacher, to use in connection with his other works on the subject, than for the pupil. The author takes strong ground against the hypothesis of Lamarck and Darwin.

13. *On Species of Fossil Plants from the Tertiary of Mississippi*; by LEO LESQUEREUX. 24 pp., 4to, with 10 lithogr. plates. (From the Trans. Am. Phil. Soc., vol. xiii.)—A brief account of the plants here figured and described was given in the Geological report on Mississippi (1860) of Eug. W. Hilgard, by whom the specimens were collected. 22 species are described from the Red shale, making with 10 before described from Somerville, Tennessee (this Jour., II, xxvii, 363), 32 species; and 6 from the White soft clay of nearly the same age. They pertain to what Prof. Hilgard calls the North Lignitic group. One species, the *Calamopsis Danai* Lesq., is given in Dana's Geology, from a drawing furnished the author by Prof. Lesquereux. The other species are of the genera *Sabal*, *Salisburia*, *Populus*, *Salix*, *Quercus*, *Ficus*, *Laurus*, *Cinnamomum*, *Banksia*, *Persea*, *Ceanothus*, *Sapindus*, *Rhamnus*, *Juglans*, *Magnolia*, *Asimina*, *Phyllites*. Two of the plants of the genera Rhamnus and Phyllites are referred to living species, and the whole are pronounced by Lesquereux to have close relations to Miocene species. Yet he admits a resemblance to the Cretaceous plants of the Upper Missouri, and leaves the question of age unsolved for want of more data. Prof. Lesquereux closes his memoir with descriptions of fossil leaves from the "Upper Cretaceous" of Fort Ellsworth, Nebraska.

14. *State Geological Survey of Iowa. Preliminary notice of New Genera and Species of Fossils ;* by C. A. WHITE, M.D., State Geologist, and O. H. St.John, Assistant. 4 pp., 8vo.—Professor White mentions in this sheet, the occurrence of Protozoan shells of the genus *Amphistegina* in the Coal-measures of Iowa. He also describes the following species; *Aulosteges spondyliformis*, *Waldheimia compacta*, *Beyrichia lithofactor ;* and the new genus *Meekella* to include as the typical species *Orthisina Missouriensis* Swallow (*Orthisina striato-costata* Cox), together with *Orthisina Shumardiana* Swallow, *Productus eximius* Eichwald, *Streptorhynchus occidentalis* and *S. pyramidalis* Newberry.

15. *Revue de Géologie pour les années*, 1864 et 1865, par M. DELESSE, Ingénieur en Chef des Mines, Prof. Géol., etc., et M. DE LAPPARENT, Ingénieur des Mines, Vice-Sec. Soc. Géol. de France. 279 pp., 8vo. Paris, 1866.—This annual is much like its predecessor noticed in volume xli. While not a complete review of the Geological papers of the years 1864, 1865, it contains much to interest all who would follow the progress of the Science of Geology.

III. BOTANY AND ZOOLOGY.

1. *Flora Orientalis, sive Enumeratio Plantarum in Oriente a Græcia et Egypto ad Indiæ fines hucusque observatarum ;* auctore EDMOND BOISSIER. Vol. I, *Thalamiflore.* Basel and Geneva, 1867. pp. 1017, roy. 8vo.—We have just received this first volume of the flora of the Orient, with which, as is well known to botanists, Mr. Boissier has long been engaged. It is greatly needed, and will no doubt be ably and indefatigably carried on, we trust to an early completion. It connects the proper flora of Europe with that of Africa on the one hand, and of India and Siberia on the other; and covers the most interesting of all lands, Palestine and all Syria, Mesopotamia and Persia, Egypt and Greece. The preface briefly sketches the general characters of these regions, the botany of which is thus combined, notes the explorers who have made collections in any of them, from Rauwolf, Tournefort, and Wheeler down to the present time, indicates the districts in which he has himself botanized, and enumerates generally the sources of the various materials available for this work. He explains the plan of the publication, and the principles by which he is guided. He announces his conviction that species are direct creations as such, and fixed in character, variable more or less, but only within certain limits. To specific names he prefers to append the original authority for that name under whatever genus it may have fallen: e. g. "*Matthiola tristis* L. sub Cheirantho,"—although Linnæus, who had both genera, referred this species to *Cheiranthus.* In their orthography, he continues to write geographical adjective names with a capital initial, after the manner of DeCandolle, e. g., *Matthiola Arabica*, an usage which has never been universal, and from which in general there is a tendency to recede; while on the other hand, he writes proper substantive specific names with a small initial, e. g. *Ranunculus flammula*,—in which perhaps he stands nearly alone. Neither the species nor the genera are numbered. The name, specific character, and synonymy form one paragraph, the habitat another, in smaller type, descriptive notes or observations (when there are any) a third, and the geographical distribution, when wider than the limits of the work, is indicated in a fourth paragraph. Varieties also occupy separate paragraphs. The whole arrangement is very clear and convenient; but the type is so large and the page so open that the work will be more bulky than we should have thought expedient. Of its substantial excellence and conscientious accuracy there can be no doubt. A. G.

2. *Catalogue des Végétaux Ligneux du Canada, pour servir a l'Intelligence des Collections de bois économiques envoyées a l'Exposition Universelle de Paris*, 1867; par l'Abbé OVIDE BRUNET, etc. Quebec. 8vo

pamph., pp. 64.—Professor Brunet has brought out this convenient catalogue for the special purpose mentioned in the title; but it ought to be otherwise useful. He has not numbered the species, nor given their enumeration, so that we cannot without counting ascertain how many woody plants Canada can boast of. Plants so little woody as *Clematis Virginiana*, and even *Chiogenes*, and *Helianthemum Canadense* are included. But there is no mention of *Smilax*, nor of *Juniperus Sabina*, nor of the Red Spruce, nor Gray Oak, both probably mere varieties of other species, but worthy of examination by Canadian botanists. There are, also, two distinct kinds of Mountain Ash growing in the vicinity of Quebec, which Canadian botanists should notice.

Histoire des Picea qui se rencontrent dans les limites du Canada, is a smaller pamphlet by the same author, issued in 1866, with a plate of the two species, *P. alba* and *nigra*—the White and Black Spruce, and two photograph views of trees of the former. The glaucous-leaved variety of the Black Spruce, the common and almost the sole form of the species in Eastern New England, is named by Prof. Brunet, var. *grisea;* it is popularly called in Canada *Epinette Blanche*, or *Gray Spruce.* Spruce beer (made from Black Spruce), it appears, is an early invention. Prof. Brunet copies from Duhamel a curious account of the manner of making it more than a hundred years ago. A. G.

3. *Report of Proceedings of the International Horticultural Exhibition and Botanical Congress held in London, May* 22–31, 1866.—We reprinted at the time the masterly address of the President of this Botanical Congress, A. DeCandolle, and notices of most of the botanical papers read at the sessions, gathered from the abstracts published in the Gardeners' Chronicle. The Honorary Secretaries, Messrs. Moore, Hogg, and Masters, have how issued an official account of the whole proceedings, in a handsome royal 8vo volume of 428 pages, with plates, maps, &c. The volume is replete with interest, both horticultural and botanical. One of the most interesting articles is that of Dr. Masters on Double Flowers, which, did time and space allow, we should have been glad to present to our readers, in full or in abstract. A. G.

4. *Collections of Dried Plants of California* are often asked for, and may now be supplied. Mr. Bolander, who has formerly supplied some Grasses, &c., in this way, has now made up, from his recent collections in California, a dozen sets of beautiful and complete specimens of about 350 species of choice Californian plants; of which over one-third are *Cyperaceæ* (chiefly *Carex*) and *Gramineæ*, and more than a quarter *Compositæ*. The specimens will be named, according to the numbers. Sets can be had for $12 in currency per hundred, by making early application to Mr. Horace Mann, at Harvard University Herbarium, Cambridge.

A. G.

5. *Growth of Lycoperdon giganteum;* by F. Moigno, in the Chem. News, Apr. 19, 1867.—The unexpected observation of the *Lycoperdon giganteum* has led M. Ernest Baudrimont to some very interesting conclusions. Fourteen days after its apparition at the surface of the ground it had acquired a considerable size. Plucked on September 17, 1866, when it commenced to decrease visibly, it was nearly of a regular spheroidal form, with a very short peduncle of a very beautiful white color, dull, and

slightly rosy; the skin was distended, and elastic under the pressure of the finger; its circumference measured 1m. 4c. on its greatest diameter, the weight being 3 kilo. 500 grams. When detached circularly by means of a sharp instrument, a great quantity of turbid liquid was disengaged of a greenish-yellow color. It was placed immediately in a baking-oven, where it remained twenty days. Taken out completely dried, it weighed 305 grams, thus showing that before desiccation it contained 91·28 per cent of water. Analysis has proved that nitrogen gas represented alone 8·96 per cent of the weight of the dried fungus, or 0·78 per cent of the weight of it in its normal state. If we suppose all this nitrogen to have been in the state of albumen, a substance which contains 17·70 per cent of nitrogen and 53 per cent of carbon, the total mass of lycoperdon (305 grams) contains 174·063 grams of carbon; we have even 142 grams by adding the carbon contained in the non-nitrogenized substances, its cellulose, &c. This being ascertained, we have 142 grams of carbon representing 520·66 grams, or 265 liters of carbonic acid, and thence 530,000 liters of air. It is from this enormous volume of air, which is about equal to a cube of 8 meters linear edge each way, that the fungus in question must have drawn, without losing a single trace, and, if we may so term it, with mathematical precision, the 142 grams of carbon necessary for its development of fourteen days. This is at the rate of, per day of twenty four hours, 10·15 grams of carbon, 18·9 liters of carbonic acid gas, and 37,800 liters of air. At 86,400 seconds per day, it is upon nearly half a liter of air that the plant must have operated per second to effect the total extraction of the carbonic acid gas which was in it. By what means can we estimate the prodigious activity that this inferior plant could develop to be able to take in fourteen days all the carbonic acid belonging to 530,000 liters of air? How astonishing, then, must be the delicacy of the absorptive organs which seize on its flight an elastic fluid—if we may so call it—intangible, disseminated in such an enormous mass, continually moving with great rapidity! But this is not all. The mean circumference of the fungus was 0·990 m.; the radius, 0·157 m.; its volume more than sixteen millions of cubic millimeters; and its mass formed of cellules 1 millimeter long at most, and the $\frac{1}{300}$th of a millimeter in thickness, between which are placed the reproductive spores. The total number of the cellules exceeds fourteen billions (14,589,140,400); and since the development lasted fourteen days, a million of cellules had to be produced every four hours—twelve thousand cellules per second! Just let one stroke of the pendulum, and then another, be heard, and conceive, if you can, that in that space of time the fungus constructed 12,000 cellules, besides (as the spores are a hundred times at least more numerous than the cellules) 1,200,000 spores, without any sensible shock or any hurried interior derangement capable of disturbing the mysterious equilibrium that reigns through all the parts of this living body. How great, then, is the prodigious energy which animates the material substance, and which can accommodate itself instantaneously to the exigencies of life!

6. *On the Parallelism between the different stages of Life in the Individual and those in the entire Group of the Molluscous Order Tetrabranchiata;* by Alpheus Hyatt. (From the Memoirs of the Boston Society of Natural History, vol. I.)—In this paper the remarkable changes, which

take place in the advanced period of life of an Ammonite by a process of degeneration or degradation of its structural character, are shown to have a singular analogy with the gradual decline in the characters of the genera and species just previous to the extinction of the order in geological times. The analogy of the process of decline in old age with that of development during the young state is also discussed, as well as the correspondence of the latter with the first appearance and gradual increase of the order in its geological history. V.

7. *Notes on the Radiata in the Museum of Yale College, with Descriptions of New Genera and Species;* by A. E. VERRILL. (From the Transactions of the Connecticut Academy of Arts and Sciences, Vol. I, Part II, 1867.)—*No.* 1. *Descriptions of New Starfishes from New Zealand.* Published March, 1867.—In this paper four new species of starfishes are described, two of which represent new genera, viz., *Cœlasterias australis, Coscinasterias muricata, Asterina regularis,* and *Astropecten Edwardsii.* The genus *Cœlasterias* is allied to *Asterias,* having four rows of suckers, but is multiradiate, with a large disk and large swollen arms. It has the aspect of *Solaster. Coscinasterias* is an allied genus, also with numerous rays, which are long and slender, arising from a comparatively small disk.

No. 2. *Notes on the Echinoderms of Panama and West Coast of America, with Descriptions of New Genera and Species.* Published, in part, March, 1867.* This paper embraces a complete review of all the Echinoderms, except Holothurians, contained in the Yale College Museum, from the west coast of Central and South America. Most of the materials are derived from the collections of Mr. F. H. Bradley, who has spent the past year on that coast. Sixty-eight species are enumerated, nearly all of which are described in detail, whether new or previously known. Twenty-two new species are included in this paper, together with four new genera. Among the more interesting new species are the following: *Astrophyton Panamense, Ophiura Daniana, Hemipholis gracilis, Ophiothela mirabilis* (new genus,) *Astropecten fragilis, A. Peruviana, Asterina modesta, Oreaster occidentalis, Mithrodia Bradleyi, Echinodiadema coronata* (new genus), *Astropyga venusta, Euryechinus imbecilis* (=E. gibbosus Val. ?), *Psammechinus pictus, Boletia viridis, Mellita Pacifica, Astroclypus Manni* (new genus), *Metalia nobilis, Brissus obesus.*

The name, *Ophiothela,* is proposed for peculiar, small, six-rayed Ophiurians allied to *Ophiothrix,* of which this group is made a sub-genus. *Echinodiadema* is allied to *Diadema* but has a spinose buccal membrane, trigeminate pores, and hollow spines. *Astroclypus* is allied to *Encope* and *Lobophora.* It differs from the first in having but four ovarial openings and in lacking the posterior perforation, and from *Lobophora* in having five ambulacral perforations, the position of the anus, etc.

Several changes in the nomenclature of known species are introduced, some of which are as follows: *Oreaster armatus* M. and Tr. is made a separate genus under Gray's subgeneric name, *Nidorellia; Echinocida-*

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* The first part of this article embracing the *Ophiuroidea* and *Asteroidea* was printed and distributed in March and April; the remaining signatures, including the *Echinoidea,* etc., were not issued until June.

ris incisa A. Ag. (*E. longispina* Lutk.) is referred to *E. stellata* Ag.; *Boletia rosea* A. Ag. is referred to *Lytechinus; Encope tetrapora* Ag. (*non* Gm.) is redescribed under the new name, *E. occidentalis* ; *Kleinia nigra* A. Ag. is referred to *Meoma* Gray; *Metalia* (Gray's subgenus of *Brissus*) is made identical with *Xanthobrissus* A. Ag. Four species of *Heliaster* are recognized.

The last part of the paper contains a discussion of the Geographical Distribution of the West Coast Echinoderms, with comparative lists of all the known species of various localities, and also a list of the West Indian and Aspinwall species for comparison with those of Panama.

8. *Remarkable Instances of Crustacean Parasitism ;* by A. E. VERRILL. —In a collection of about ninety specimens of a small sea-urchin (*Euryechinus imbecillis* Verrill) from the coast of Peru, not one could be found in which the anal area and surrounding parts of the upper side of the shell were not more or less irregularly distorted, or imperfect. An examination of the interior showed that in each specimen a crab (*Fabia Chilensis* Dana), allied to the common crab of the oyster (*Pinnotheres ostreum*), had effected a lodgment in the upper part of the intestine, which had thereby been greatly distended in the form of a membranous cyst, attached to one side of the shell, and extending around to the lower surface near the mouth. The shell is usually swollen on the side over the cyst, and the anal area is depressed and distorted, with a large open orifice passing obliquely into the cyst, out of which the crab may thrust its legs at pleasure; but is apparently unable, when full grown, to come entirely out. All the specimens examined in the cyst were females, carrying eggs, but a very small crab found clinging among the spines appears to be the male. The crab probably effects an entrance into the intestine through the anus while quite young, and, by its presence and growth in that position, causes the gradual distortion of the shell and formation of the cyst. In Prof. Dana's Report on the Crustacea of the U. S. Expl. Expedition this crab is described as from Valparaiso, from an Echinus, but no special notice of its mode of occurrence and remarkable frequency appears to have been published.*

Another peculiar mode of parasitism I have observed in a singular crustacean (*Hapalocarcinus marsupialis* Stimpson†) from the Sandwich Islands. This creature lodges itself among the slender branches of a coral (*Pocillipora cæspitosa* Dana) and causes, probably by its incessant motions, the branches to grow up and surround it on both sides by flat expansions of coral, terminating in digitations, which often interlock above, leaving openings between them suitable for the uses of the parasite, but usually too small to allow of egress. Most specimens of the corals of this species sustain one or more, and often numerous, examples of these curious enlarged bulbs among the branches. The habits were unknown to Dr. Stimpson, when he described his specimens, which had dropped from among recently collected corals.

9. *On the external characters of the Young of the Central American Tapir* (*Elasmognathus Bairdii* Gill); by A. E. VERRILL.—This remarkable animal has hitherto been known only by its skull, and a skeleton, not

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* *Pinnaxodis hirtipes* Heller, recently described fram Ecuador and found in an *Echinus*, is probably the same species.

† Proceedings Boston Soc. Nat. Hist., vi, 412.

entirely complete, belonging to the Smithsonian Institution. The Museum of Yale College has recently been so fortunate as to receive from J. H. Sternberg, Esq., a specimen of the young animal, preserved entire in alcohol. This individual is a female, and is supposed by Mr. Sternberg to have been about three months old in April. He states that its weight is not more than that of the head of the adult, one head that he formerly examined weighing 82 pounds.

Its entire length is 31 inches; nose to occiput 11; nose to eye 4·25; nose to incisor teeth 1·5; eye to ear 3·2; lower jaw 6·5; length of ear 3·5; breadth 2·5; tail from vent, not including hair, 2. The legs are short and stout. The tail small and inconspicuous. The head, viewed from the side, is elongated oval; from above elongated triangular, the sides nearly straight, the nose truncated. In advance of and above the eyes, the sides of the nose are compressed and concave, with a slight depression on its ridge. Beyond this the snout is enlarged, and convex both on the sides and above; the tip papillose and slightly decurved, which gives it a truncated appearance. The nostrils are large, oval, placed obliquely at the end of the nose, about half an inch long, the inner angles separated about a quarter inch, the margins thickened. The nose itself is quite flexible and, apparently, capable of extension. The ears are large and prominent, broad oval, rounded at the end. The hair is rather fine and soft, about an inch long on the body, and half as long on the head, where it is not so thick.

The general color is bright reddish-brown, the head darker above. The lips and end of the nose, bordering the naked, black tip, are white. Five interrupted narrow white stripes pass along each side of the nose, the upper one extending over and beyond the eye. The cheeks have several larger patches of whitish, one of which is under the eye; a larger white spot is on the throat. The ears are dark brown, lighter at the outer base, the tips, and several unequal spots on the outside, white. The back and sides are marked by longitudinal rows of yellowish-white patches, which partially blend into continuous stripes on the sides. There are in all about ten of these stripes. The under side of the body is uniform yellowish gray. The legs are darker brown than the body, and marked by numerous transverse bands and spots of white.

IV. ASTRONOMY.

1. *Prof. Adams upon the orbit of the November meteors.*—It was shown some time ago (this Journal, II, xxxviii, 57) that the periodic time of the November meteors must be one of five accurately determined periods. These five periods were 180·0 days, 185·4 days, 354·6 days, 376·6 days, and 33·25 years. The longitude of the node was also shown to increase with respect to the ecliptic 1′·711 in a year, which is equivalent to a procession with respect to the fixed stars of 29′ in a cycle of 33·25 years. It was also suggested that by computing the theoretical secular motion of the node for each one of the five possible orbits, and by comparing it with the observed motion we have an apparently simple means of deciding which of the five orbits is the true one.

Soon after the remarkable display of the meteors in November of last year, Prof. Adams undertook the examination of this question. Taking first the orbit corresponding to a periodic time of 354·6 days, he found that the action of Jupiter produces an annual increase of the longitude of the node equal to 6″, and that of Venus an annual increase equal to 5″. The action of the earth was not so easily computed, owing to the intersection of the two orbits. An approximate solution applicable to this case showed, however, an annual increase of the longitude of the node of about 10″ due to this cause. The whole computed procession of the node was therefore about 21″ a year, or 12′ in the cycle of 33·25 years. The periodic time, 376·6 days, gives a result not widely different from the above, while in the two smaller orbits there would be a much smaller motion. Hence these four orbits, out of the five possible ones, are incompatible with the observed motion of the node.

Computing then the effect of the perturbing action of the planets upon the group, supposing it to have a periodic time of 33·25 years, Prof. Adams found that Jupiter increases the longitude of the node 20′ in one revolution, that Saturn increases it 7′, and Uranus increases it 1′. The other planets produce hardly any sensible effects, so that the entire calculated increase of the longitude of the node in the period of 33·25 years is about 28′. The observed increase during the same time is 29′. This remarkable accordance between the results of theory and observation appears to leave no doubt as to the correctness of the period of 33·25 years.

2. *Connection of Comets with Meteors.*—The remarkable relation between the Comets III 1862 and I 1866 and the August and November meteors naturally suggests a possible connection between other comets and other real or suspected meteor-showers.

Dr. Weiss of Vienna,[*] using a list of dates of star showers obtained from Humboldt, Quetelet, and Heis (overlooking the necessity of referring the showers to a fixed equinox), has computed the radius vectors of various comets at their two nodes, and finds the following coincidences. In the last column R – r is the earth's radius vector at the node, minus that of the comet. We give the whole table notwithstanding the fact that some of the showers are uncertain. The two dates in April belong to the same shower.

Date of shower.	Nodal passage.	Comet.	Node.	R – r.	
Jan. 1–4,	Jan. 3	II. 1792	☋	−0·073	
" "	" 4	IV. 1860	☊	+0·025	
Apr. 4–11,	Apr. 13	837	☊	−0·021	Very uncertain orbit.
" 20–24,	" 20	I. 1861	☋	0·002	
July 27–29,	July 27	II. 1737	☋	+0·005	
Sept. 18–25,	Sept. 17	I. 1790	☋	−0·054	Uncertain orbit.
" "	" 17	I. 1763	☊	−0·016	
Oct. 19–26,	Oct. 19	1779	☊	+0·024	
" "	" 20	1739	☋	−0·078	
" "	" 21	1097	☋	+0·056	
" "	" 24	1366	☋	−0·054	
Nov. 28,	Nov. 28	Biela's	☋	−0·018	
Dec. 6–9,	Dec. 9	IV. 1819	☊	+0·085	

The Comet II 1852, as well as III 1862, crosses the path of the earth on the 10th of August. Dr. Weiss suggests this as a cause of the want of definiteness of the August radiant, and of the duration of the shower.

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[*] Astron. Nachr., No. 1632.

Prof. D'Arrest shows* that the meteors of the 6–7th of December have a radiant which is well represented by supposing them to have been formerly connected with Biela's comet. The longitude of the earth at the time (Dec. 6–7th) is 74° – 75°, while the longitude of the node of Biela's comet from 1772 to 1832 was from 73° to 68°.

De Galle also shows† that the radiant for April 19–20th, which was given by Mr. Herrick as near α Lyræ in 1839, and which was found by Mr. Alex. S. Herschel to be at that point in 1864, differs only 7° from what would result from an orbit like that of comet I. 1861. This is within the possible error of observation.

The comet I. 1861 was discovered by Mr. A. E. Thatcher at Mr. Rutherfurd's observatory in New York City. At its brightest, it was equal to a star of the 2d or 3d magnitude.

Mr. Schiaparelli argues‡ that the mass of Uranus is so small that it is impossible for it to have turned the group of November meteors out of an orbit differing much from that described at present, without having at the same time entirely scattered the group. The perturbing body, which caused the change from a parabolic or a long elliptic orbit, is then either Jupiter or Saturn. It seems, therefore, to be necessary to reject the hypothesis of LeVerrier, that the great perturbation of the stream was due to Uranus and occurred in the year 126 of the Christian era.

Mr. Faye has presented to the Paris Academy of Sciences a hypothesis which connects the shooting stars, the zodiacal light, the rays of the corona seen in a solar eclipse, and the resisting medium which is believed to shorten the time of Encke's Comet, with the matter which is seen to flow from the nuclei of comets, forming their comas and tails. H. A. N.

3. *Observations of Shooting Stars, May 12th*, 1867.—It was thought that if the period of the November meteors was 354·6 days, we should probably meet a few straggling members of the group at the ascending node of their orbit, that is, on the 12th of May, 1867. The denser portion of the group of meteors would in six months, perhaps, have passed beyond the node. But if no stray members were to be seen *going toward Leo*, the evidence, though negative, would confirm the 33¼ year period. Accordingly, at Chicago, at Williamstown, at Olivet, and at New Haven, a watch was kept on that morning.

At Chicago, Mr. Francis Bradley, between a quarter before two and half past three o'clock saw but nine shooting stars, of which only two reminded him of the November meteors. Even the paths of these, as described in his letter, could not be regarded as going directly toward Leo.

At Williamstown, Mass., Mr. Leavitt saw 18 meteors between $1^h\ 50^m$ and $3^h\ 40^m$, five of which were noticeable as leaving the white train characteristic of November meteors. The paths of two of these are given in his letter. If produced they would pass a moderate distance from the Sickle.

At Olivet, Mich., Prof. Hewitt and Mr. Gaines, between $1^h\ 45^m$ and $3^h\ 15^m$, saw 28 shooting stars. There seemed to be a tendency to radiate from a region north of Aquarius, between that constellation and Pegasus.

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* Astron. Nachr., No. 1633. † Ibid, No. 1635.

‡ Les Mondes, xiii, 501, March 28, 1867.

On the same morning, in the hour between 2^h and 3^h, A. M., Mr. A. Van Name, Mr. O. Harger, and the writer, saw at New Haven 34 meteors, most of them small ones. Only three or four of these were regarded as going toward Leo. These did not present in their physical appearance resemblances to the November meteors.

The result of the whole of the observations on this evening was to confirm the $33\frac{1}{4}$ year period. Since that time the remarkable results of Prof. Adams's computations have been received, which leave no longer the possibility of a doubt as to the true period. H. A. N.

4. *Elements of Comet* III, 1862.—Dr. OPPOLZER of Vienna, has given in the Astronomische Nachrichten, No. 1638, the following corrected elements of the Comet III, 1862, which is connected with the August group of meteors.

$$\begin{array}{rcl}
 & & \text{Osculation: 1862, Aug. } 23{\cdot}0 \\
T & = & \text{Aug. } 22{\cdot}947139 \text{ Berlin m. t.} \\
\begin{array}{r}\pi\\ \Omega\\ i\end{array} & \begin{array}{c}=\\=\\=\end{array} & \left.\begin{array}{l}290^\circ\ 12'\ 47''{\cdot}84\\ 137\ \ \ 27\ \ 10\ {\cdot}02\\ 113\ \ \ 34\ \ 12\ {\cdot}24\end{array}\right\}\text{ mean equinox } 1862{\cdot}0 \\
\log q & = & 9{\cdot}9834650 \\
e & = & 0{\cdot}9607588 \\
\log a & = & 1{\cdot}3897227 \\
\text{per. time} & = & 121{\cdot}502 \text{ years.}
\end{array}$$

Schiaparelli suggests a period of 108 years for the August meteors, the suggestion being based upon the following dates of star showers, from Quetelet's and Biot's catalogues; viz., 830, 833, 835, 841, 925, 926, 933, 1029, 1243, 1451, 1779, 1784, 1789.

A period of 108 years is however regarded by Dr. Oppolzer as incompatible with the observations, unless by allowances of errors which are altogether improbable. Planetary perturbations play a small part, it is believed, in the theory of this stream, as an exact determination of its period will doubtless show that it does not come near any planet except the earth.

5. *Comet* II, 1867.—A faint comet was discovered by Mr. Tempel at Marseilles on the third of April, 1867.

6. *Division of Biela's Comet.*—Prof. Bruhns of Leipsic, notices the fact[*] that at the time of the discovery of the division of Biela's comet it was crossing the path of the November stream. It seems hardly possible, however, that the density of the stream could have been sufficient, at that time and place, to have accomplished the separation.

7. *The Moon-crater "Linné."*—In the center of the bright spot which covers the former crater "Linné," there appears a minute black point, indicating a crater of about 600 yards diameter. The original crater appears to have been a deep one, and about 10,000 yards in diameter. This small crater was so plainly visible as to have been noticed (independently as it would seem) by Dr. Schmidt at Athens, by P. Secchi at Rome, and by Prof. Lyman at New Haven. It was detected here three days after the sun had risen over the horizon of "Linné," and when the sun was therefore 30° or 35° high upon it. These observations show that any change which has taken place is not in the nature of a development

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[*] Astron. Nachr., No. 1631.

of a cloud, but imply rather that the old crater has been filled up by an eruption from the small one now visible.

According to Prof. Respighi of Rome, the western margin of the small crater in "Linné" is higher than the eastern, and was even visible as a bright point just before the sun rose upon the crater. He thinks that the historical evidence is not sufficient, however, to prove beyond doubt that a change has taken place.

Dr. Schmidt states that numerous and careful observations made during the four lunations, both in the waxing and in the waning moon, prove that "Linné" under no direction of the sun's light can now be seen as a normal crater.

Mr. Flammarion at Paris, observing carefully the place of "Linné" immediately after the rising of the sun upon it, could not detect the least shadow either within or without the position of the former crater. The fact that the height of the mountain was never given by the earlier observers he adduces as proof that it did not then have great altitude above the surrounding plain. Watching the place of "Linné" before the sun rose upon it he saw no light.

8. *Der Meteorsteinfall am* 9 *Juni*, 1866, *bei Knyahinya* (*zweiter Bericht*); von W. Ritter v. Haidinger. 48 pp., 8vo, with 3 plates; from the Berichte Akad. Wien., liv, Oct. 1866.—Haidinger here gives additional testimony with regard to the meteorite which was seen to fall a year since, in Hungary, 25 geographical miles N.N.E. of Unghvár, and 6 N.N.E. of Nagy Berezna. The remarkable facts and appearance attending the movement and fall are fully described from communications by many eye-witnesses, and illustrated with colored figures. The whole weight of the pieces that fell was about 900 pounds, and one piece is stated to have a weight of 550 pounds (Austrian). The memoir gives the exact geographical positions of the principal observers and discusses the movements of the meteor.

Haidinger, whose contributions to the department of meteorites have far exceeded in number and value all those of other contributors, and who has now become a veteran among philosophers, observes in a note accompanying the copy of the above mentioned memoir, that, while thus laboring for the progress of the science, he has never made any collections of meteorites for himself; and he now appeals frankly to the generosity of those who have made such collections for "such one or another fragment of meteorites or meteoric irons, as they may have at hand for disposal." He adds "I ask this as a free gift, to be received by me without any substantial retribution or equivalent, excepting the most cordial thanks for such great proofs of a liberal heart." Such gifts as he thus solicits are due to the liberal-hearted Haidinger. We rejoice to learn that he has been "honorably placed in retirement" by the Emperor as director of the I. R. Geological Institute of the Austrian Empire.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Earthquake in Kansas.* (1.) Notice of the earthquake by WM. H. R. LYKINS, from a letter to the editors, dated Lawrence, Kansas, April 25, 1867.—Yesterday the 24th of April, at 3 P. M., this locality was visited by an earthquake quite severe for this latitude. It was accompanied by the usual loud rumbling noise similar to that caused by the passing of half a dozen heavy omnibuses. The earth did not seem to rise or rock, but to tremble or vibrate. No dust was raised nor was there any unusual atmospheric disturbance perceptible; the weather being clear and cool. Doors and windows were violently shaken, type thrown down in printing offices, bottles shaken off druggists' shelves, plaster broken off, and in some instances walls slightly cracked. Persons out of doors did not feel any movement of the ground, but could see the buildings tremble. A butcher informed me his spring balance was drawn down a pound and a half by the shock. It commenced with a slight trembling, gradually increasing to its maximum and then gradually dying away; lasting, as near as I could judge, about thirty seconds, though some estimate its duration at one and a half minutes. Some professed to have felt three distinct shocks, but the majority described it as a gradually increasing and decreasing vibration. The same shock was felt simultaneously one hundred miles west and north of us; from places farther than this we have no information.

(2.) Notice of the earthquake by Prof. WM. G. WILLIAMS, from a letter to the editors, dated Marysville, Marshall County, Kansas, April 25th, 1867.—At two o'clock and thirty minutes yesterday afternoon the shock of an earthquake was felt probably in every house and place of business in and near town. It was accompanied by the usual rumbling sound, and lasted a time variously estimated from one to three minutes.

No serious injury was done to persons, or property, beyond a temporary alarm on the part of a few. In stores, bottles and packages were made to rattle and in some cases were shaken from the shelves and broken. Windows, doors, shutters, stove-pipes and all loose or hanging articles, rattled, waved, or swung back and forth fearfully.

In several instances persons in the second stories of stores and houses, hearing the noise, and seeing and feeling the unwonted motions, ran down to stop the supposed disorder and tumult below, while those below ran up to stop that above. One lady knowing it to be an earthquake seized her infant child and hastened down stairs with a view to get out of doors for safety. A gentleman fishing in Spring Creek near town was leaning against a tree, feeling it shake and looking up, he saw it and other trees trembling and moving as if agitated by wind, although no breath of air was stirring. With my assistant teacher and some seventy scholars I was in the second story of our High School edifice. It is of stone and high pitched. The whole structure, desks, stove-pipes and other furniture were much shaken. The rumbling noises below much resembled those of heavy trunks on plank floors. I have had no opportunity to learn how extensively the shock was felt.

2. *On former changes in the Aral Sea;* by H. C. Rawlinson, (from Proc. Roy. Geogr. Soc., March 11, 1867.)—There were certain points connected with the rivers Oxus and Jaxartes which he proposed to bring prominently before the meeting. They referred to a physical phenomenon which he believed was without parallel in the rest of the world, being, indeed, neither more nor less than the drying up at certain periods of history of the Sea of Aral, and its consequent disappearance from the map of Asia. The Aral, in terrestrial geography, might be compared with one of the variable stars in astronomy. As there were stars varying from the first to the fifth magnitude, so the Aral was at times a great inland sea 300 or 400 miles in length, at other times a mere reedy marsh, and even, occasionally, a hard desert land, so that travellers actually passed across it without being aware that they were travelling over the bed of a sea. Humboldt had devoted 200 pages of his famous work 'Asie Centrale' to the discussion of the geography of the Aral and the Caspian, and he had established beyond dispute that the Oxus had a variable course, sometimes falling into one sea and sometimes into the other; but he had not ventured to assert that the Aral ever disappeared altogether. Nevertheless, he (the Chairman) maintained that we had direct evidence of the fact in modern times, and he thought we had a right to assume its occurrence in ancient times.

The argument was briefly as follows: In all classical antiquity, from the earliest date, say from 600 years B.C. to 500 or 600 years after Christ—the Sea of Aral was utterly unknown in geography. There was not one single authority—Greek, Latin, or native Persian—who mentioned it. The two great rivers, the Oxus and the Jaxartes, which, by their contributions now form that sea, were described by all authors as falling into the Caspian. It must be remembered, too, that Alexander the Great conducted an army into that part of Asia, and employed officers for the express purpose of ascertaining the geographical configuration of the neighboring countries. He sent his troops on an expedition along the shores of the Caspian, while he in person crossed the Oxus, and reached the banks of the Jaxartes. Hence he must have possessed accurate information as to those localities, and yet the account which his officers brought back to Greece was that both the rivers fell into the Caspian. This statement, indeed, was adhered to throughout antiquity, and a practical proof was given of its truth in the notice of the line of commerce which supplied Europe with the products of Asia. This commercial route was described as starting from the foot of the Indian Caucasus, following the Oxus down to the Caspian, ascending the Kur or Cyrus, and descending the Phasis into the Black Sea, and thence crossing into Europe. We had thus direct evidence, as it seemed, that in the days when this route was followed and described, the Oxus must have fallen into the Caspian.

The Chairman went on to say, that as the present Sea of Aral filled an inconsiderable depression in the table-land of Central Asia, having no springs, and being entirely dependent for its supply on the two great rivers already mentioned, so it followed that if those rivers at any time were diverted from the Aral, the sea would necessarily become desiccated in a very few years, and the bed of it would revert to its original condition of a mere depression in the desert. The levels were a very important element in considering this question. That of the Aral was 117 feet above the level of the Caspian, and 33 feet above the Black Sea, the Caspian itself being 84 feet below the Black Sea; so that if a communication were formed between the Aral and the Caspian, the Aral would naturally drain off into the lower basin. To proceed, however, with the argument. If, in the times of classic antiquity, there was a unanimity of evidence that the Oxus and Jaxartes flowed into the Caspian, so, from the beginning of the Mohammedan era, say from the year 600 to about 1300, or for a period of seven hundred years, there was an equal unanimity exactly the other way. During this period the Arabs and their political successors were in possession of the country. They were a literary and scientific people, and wrote numerous works on geography. They possessed the means of ascertaining full topographical details, and they invariably represented the two rivers as falling into the Sea of Aral, or the Lake of Kharesm, as it was then usually called. The only reasonable inference then seemed to be, that between the years 500 and 600 the course of the two rivers, owing to some natural disturbance, must have changed, and that, instead of continuing to fall into the Caspian, they became diverted into the sea of Aral, themselves, in fact forming that sea. Now came the most curious part of the question. From about the year A. D. 1300 to 1500, that is, for about 200 years, Europeans possessed means of becoming acquainted with the geography of Central Asia which had never been equalled up to the present day; for there were at that time frequent missions sent from the courts of Europe to Mongolia in Central Asia, and the ambassadors so employed had for the most part preserved records of their journeys. Colonel Yule, an associate of the Geographical Society, had recently brought a general summary of those records before the notice of the public in a most interesting work ('Cathay and the Way Thither'), of which he (the Chairman) could not speak too highly, and which he could not too strongly recommend to the notice of all lovers of geographical science. Colonel Yule's book contained records of many travels across Central Asia during the 13th and 14th centuries, and in not one of those records was the Aral mentioned, although the route of the travellers lay in most cases exactly across it. One of the authors in question, named Pegoletti, gave all the details of the commercial route at that time, which conducted from the Black Sea to China, and along which merchants conveyed the luxuries of Europe, and returned with the tea and silk of China. There were, indeed, detailed notices of the route in question, not only in the itineraries of Pegoletti, but in the maps which were constructed from memoranda furnished by travellers between the 13th and 16th centuries. One of these was called the Catalan Map; another was a map preserved in the Palatino Library at Florence; another was the Borgian Map, and the most famous of all was the Venetian map of Saint Mauro; and in none of these was the Aral noticed. The travellers came in the first instance from the Volga to Sarachak, on the eastern shore of the Caspian; and from thence they passed to Otrar, on the Jaxartes, the route lying across the bed of the Aral, which, nevertheless, in no single instance was either mentioned in the itineraries or laid down in the maps. On these negative grounds alone he should consider it quite certain that at that time the Aral did not exist; but we had fortunately positive evidence to confirm that conclusion.

Probably some of those present had heard of a very famous man called

Yar Mahomed Khan, who was chief of Herat during the period of the Afghan war about twenty-five years ago. This person had sent to him (the Chairman) during the war, as a token of friendship, a Persian manuscript, which seemed to be of very great value on account of its rarity. It was a work written by an officer of the famous ruler of Herat, Shah Rukh Sultan, and contained, amongst other matters, a geographical account of the province of Khorassan about the year 1418. The writer seemed to have been a minister of the country, and evidently knew every village and stream in the province. He (the Chairman) had made three extracts from the manuscript, which he considered to be of the utmost importance, as they recorded a physical phenomenon, namely, the desiccation of the Aral, which he believed had never up to the present time been brought to the notice of the geographers of Europe, although, as before stated, the great Humboldt had devoted no fewer than 200 pages of his standard work to the discussion of this subject. In describing the lakes of Asia the writer came in regular order to the Aral, which was called the Lake of Kharesm, and he said, "In all the ancient books the Lake of Kharesm is described as the receptacle of the waters of the Oxus, but at the present date, which is A. H. 820 (A. D. 1417), the lake no longer exists, the Jyhún (or Oxus) having made a way for itself to the Caspian, into which it disembogues at a spot called Karlawn, as will be described hereafter in its proper place." Again, in describing the rivers of Asia, he said, "It is recorded in all the ancient books that from this point the River Jyhún (or Oxus) flows on and disembogues into the sea of Kharesm; but at the present day this sea no longer exists, the river having made for itself a new channel, which conducts its waters into the Caspian. The point of embouchure is named indifferently Karlawn and Akricheh. From Kharesm to the point where the river falls into the Caspian the greater part of the country is desert."

So much for the Oxus. With regard to the Jaxartes, this writer explained another point which was of some importance; for, although the Oxus might have been diverted into the Caspian, still, if the other river entered the Aral, it would still remain a sea. But it was stated as follows:—"The river of Khojend in the lower part of its course, passing into the desert of Kharesm, joins the Jyhún (or Oxus), and thus ultimately reaches the Caspian." From which passage he (the Chairman) understood that at that time, A. D. 1417, the Jaxartes below Otrar branched off from its present bed to the left hand along a line now marked by reeds and lagoons (see Meyendorf's map), and joined the Oxus between Kungrad and Khiva, the two rivers from that point flowing on to the Caspian in one and the same bed. This statement was of the more importance as it came from a writer thoroughly acquainted with the country. In addition to this, there was the testimony of the great Emperor Baber, who of course knew the geography of his own country, and who said that the Jaxartes in his time did not enter the Aral, but was lost in the desert. His (the Chairman's) belief was that it sometimes reached the Oxus, and was sometimes evaporated in the desert.

Such is the history of the Oxus and Jaxartes up to about the year 1500. From that time a second change began to take place. The rivers were then found to be going back into the Aral. It might not be generally known that Mr. Anthony Jenkinson, the agent of some English merchants, passed across Central Asia to Bokhara as early as 1550. He landed on the shore of the Caspian at Ming-kishlag, and came down the coast to a point where, as he heard, the Oxus had formerly disembogued into the sea; but he was told that the river had lately changed its course and gone back into the Sea of Aral. The ruler of the country, Abul-Ghazi Khan, who had left a most elaborate history of it, gave distinct details of this occurrence, and mentioned the very year in which the river began to return into the Aral. He related how the stream gradually dried up, and formed the sea as it at present exists. Evidence indeed could be given of the condition of the stream, almost year by year, from that time to the present; but it would be sufficient to state that every modern traveller who had passed through those regions had found the old bed of the River Oxus exactly where it was originally described. It was first brought to our notice by Mouravieff, a Russian agent, who passed from the Balkan bay to Khiva in 1819. Subsequently Arthur Conolly, who was afterwards murdered at Bokhara, attempted to cross from Astrachan to Khiva, and he also came upon the old bed; and lastly Mr. Vambéry, whom the Fellows might remember seeing at a meeting of the Society two years ago, in his famous journey across the Turkoman desert, traced the same broad river-bed, and found that it was perfectly well known as the ancient bed of the Oxus. Hence it seemed that there was sufficient evidence to show that in early times, say from the year 500 before the Christian era to the year 600 after the Christian era, both the rivers ran into the Caspian, the Aral being non-existent; that after that, up to the year 1300, they fell into the Aral; that for the next two hundred years—namely, from 1300 to 1500—they came back into the Caspian; and that then, at a fourth stage, they gradually flowed back into the Aral, and formed the sea as we now know it.

The changes thus noticed were very important in reference to what might be the future history of these rivers and these countries. It was quite certain that, as the Jaxartes was now in the possession of Russia, so the Oxus must also naturally and necessarily be, in the course of time. Now he would read what was stated by Russian writers as the probable result of that event. The Russians almost always called these rivers by the names of the Amu Daria and the Syr Daria, instead of the Oxus and the Jaxartes; but he would, in reading the extract, use the latter names as being better known:—

"The Oxus is, for many reasons, of great importance to Russia than even the Jaxartes. It disembogued at one period into the Caspian, and its bed to that sea still remains. Some are of opinion that the course of the river can be again directed to its ancient bed, while others consider it impossible to do so. It can, however, be positively asserted that the existing information on this point is very superficial and inaccurate, and the question will never be satisfactorily settled until a scientific expedition be sent by the Government to investigate it in all its bearings. The southeastern shores of the Sea of Aral are well adapted for uniting the Jaxartes with the Oxus, and encourage the hope that the united mass of water of two such great streams may force their way through the old bed to the Caspian. The importance of this connexion will readily be understood, when it is remembered that a water-route in continuation of the Volga will be thus created, which will extend for 3000 versts into the interior of Asia, and that the extreme points of this uninterrupted water-way will be St. Petersburg and the northern slopes of the Hindoo Koosh."

This was a result which he (the Chairman) considered highly probable, and he believed that many present at the meeting would live to see a direct water-communication from the Baltic to the vicinity of the Indian Caucasus, which was considered the natural geographical boundary of India. They must remember that already there was a direct water-communication from the Neva, by means of canals, to Lake Ladoga, and thence to the upper course of the Volga, and down that river to the Caspian. Then, crossing the Caspian, vessels could reach the mouth of the bed of the Oxus. He looked upon that prospect without any apprehension or dismay, regarding it as the natural extension of civilization, and believing that it would be for the general advantage of mankind.

3. *Professor Kekulé.*—It is with much satisfaction that we see it announced that Professor Aug. Kekulé of Ghent has been offered the directorship of the magnificent laboratory now nearly completed at Bonn. No chemist of his years has done as much, either theoretically or practically, for the establishment of the present views in organic chemistry. The law of saturation, which, as Wanklyn says, is to chemistry what the law of gravitation is to astronomy, we owe to Kekulé. It is therefore a most just recognition of his ability and service to tender to him the directorship of the Bonn laboratory.

3. *American Association for the Advancement of Science.*—The next session of the American Association will be held at Burlington, Vermont, and commence on the 21st of August next. Prof. J. S. Newberry is President for the year, and Dr. Wolcott Gibbs, Vice President.

OBITUARY.

THEOPHILE JULES PELOUZE, died on Friday last, the 31st of May, at his country house at Bellevue, close to Sèvres. Born the 13th of February, 1807, at Valognes (Département de la Manche), he inherited his love for science and arts from his father, Edmond Pelouze, a man of great practical talents, formerly employed in the manufactory of Gobelins, and afterwards director of the gasworks of the Manby and Wilson Company at Paris. Pelouze the elder is known as the author of a great number of treatises on various branches of applied chemistry—on glass-making, on brick-making, on colors and varnish-making, on washing and bleaching for housewives, etc. His treatise on the last-named subjects was published under the name of his wife. His chief work, 'On the Manufacture of Gas,' was revised by his son, and came out in a second edition as late as 1859. Young Pelouze entered life as a pharmaceutical chemist; but he was only twenty years old when Gay-Lussac made him his assistant, and published some of his researches conjointly with him. Three years later, in 1830, he became professor of chemistry at Lille. Here he examined the juice of beetroot, and, in conjunction with Kuhlmann, published a paper on its fermentation. From 1831 until 1847 he took the place of Gay-Lussac as Professor of Chemistry at the École Polytechnique, and at about the same time (1831) he was elected to supply the place of Thénard as professor at the Collége de France. Shortly after these elections Pelouze managed to go to Giessen, and to publish joint researches with Liebig on the ether contained in wine, to which they gave the name of œnanthic ether, but which was afterwards proved by Delffs to be identical with pelargonic ether. In 1833 Pelouze became Assayer, and in 1846 Controller (Vérificateur) of the Mint. He was elected a member of the Académie des Sciences in 1837. Of republican views, and much interested in politics, he became prominent through the revolution of 1848. The provisional government elected him to a place which until then belonged to the nobility or to the chief dignitaries of the state, that of President to the Board of the Mint (Président de la Commission des Monnaies). This position he held until his death. He became successively knight, officer, and commander of the Legion of Honor. His private laboratory for pupils in the Rue Dauphine closed when he opened a laboratory in the mint.

The number of papers published by Pelouze is very great. We can only mention here the most prominent of his researches. Among these none will be better remembered than the investigation recorded in his paper on the transformation of hydrocyanic acid into ammonia and formic acid. This paper was published in 1834, but the importance of his discovery became evident at a much later period, when hydrocyanic acid was first produced from carbon and nitrogen. Then it was that the transformation which Pelouze had effected by treating hydrocyanic with a strong solution of hydrochloric acid attained its remarkable position as the first instance of the synthesis of an organic body from its elements. At the time of the discovery its real importance could not be appreciated, but even then the relation of formic to hydrocyanic acid was of much interest. Next in importance to this memorable paper are several papers on the products of the dry distillation of lactic, malic, and tartaric acids. Pelouze discovered lactic anhydrid and lactid. Maleic and pyrotartaric as well as pyrogallic acid, if not actually discovered were, at least, chiefly studied by him. The salts of lactic acid were likewise examined by Pelouze, and described in several papers, one of which he published conjointly with Gay-Lussac.

A memoir on mustard oil was published by Dumas and Pelouze; another on asparamid (asparagine) and asparamic acid by Pelouze and Bourton, and a joint research on curarine was published by Pelouze and Claude Bernard. In mineral chemistry nitrosulphuric acid constitutes his chief discovery. In applied science numerous contributions, particularly on fulminates and the manufacture of percussion-caps, and above all on glass, were published by him at various intervals. Pelouze had an interest in large glass works at St. Gobin, and his last communication made to the Academy, some months ago, treated on the subject of this manufacture. A treatise on chemistry in five volumes by Pelouze and Fremy has seen three editions, the last of which was published in 1866. All these publications, if they do not place him among the very first French savants, will preserve his name permanently in the history of science. His great kindness of heart, and sincere and active interest for his pupils, will not easily be forgotten. There are and have been witnesses to these genial qualities in England. Professor Crace Calvert and the late Mr. Stoikowitch were assistants to Mr. Pelouze. During the last year important researches on aniline colors were carried on in his laboratory by MM. Girard, de Laire, and Chapoteaut.—*The Laboratory*, i, 182, June 8, 1867.

EZEKIEL HAYES.—Mr. Ezekiel Hayes, whose name has appeared on the title page of this Journal as its printer, died suddenly on the 12th of May last. In all relations in life Mr. Hayes was a man of strict christian integrity; and throughout his connection with this Journal, he labored earnestly for the interests of both authors and publishers.

VI. MISCELLANEOUS BIBLIOGRAPHY.

1. *Lippincott's Vapor Index, or Psychrometric Calculator.*—The Vapor Index is a mechanical contrivance by JAS. S. LIPPINCOTT, Haddonfield, N. J., for finding, by inspection, the relative humidity of the air, from the readings of the wet and dry bulb thermometers.

In a circular card, near its margin, are twenty equidistant openings, through which may be seen on a larger card over which it turns a series of numbers (from 0 to 100), representing *wet-bulb* readings. Radially inward from these openings are corresponding ones, arranged spirally, and numbered from 0 to 25. These numbers are *differences* of wet-bulb and dry-bulb readings. The *relative humidity* is read off through the opening whose number is this difference in a given case, when the card is so turned that the wet-bulb reading is seen in the corresponding marginal opening.

The instrument is simple, and many may prefer it to a table of double entry, for obtaining the same results; although in our view such a table, printed on a smaller card than this, would be equally convenient, and more durable. But knowing of no such table on a card, we can recommend the "Vapor Index" as more easy of use than the large tables, such as Guyot's, and as sufficiently accurate for ordinary purposes. The wide distribution of the Vapor Index would tend to increase much the interest in making hygrometric observations.

Mr. Lippincott is deserving of much credit for his efforts to extend an interest in Hygrometry, both by this invention, and by an interesting paper in the Report of the Commissioner of Agriculture for 1865, in which he discusses the relations of atmospheric humidity to various important phenomena in Meteorology and Agriculture.

2. *General Problems of Shades and Shadows, formed both by parallel and radial rays, and shown both in common and in isometrical projection, together with the theory of Shading;* by S. EDWARD WARREN, C.E., Prof. Descript. Geom., etc., Rensselaer Polytech. Inst., Troy, N. Y., author of "Elementary Plane Problems;" "Drafting Instruments," etc.; "Elementary Projection Drawing;" "Elementary Linear Perspective;" and "Descriptive Geometry." 140 pp. 8vo, with 15 plates. New York, 1867. (John Wiley & Son).—In our last volume we briefly noticed Professor Warren's excellent "Plane Problems in Elementary Geometry," a work bearing on the science of drawing. In the work before us, the author treats with fulness and perspicuity, the subject of shades and shadows. The treatises of Prof. Warren are all well adapted for instruction in the Engineering and other Scientific Schools of the land.

3. *The American Naturalist*, Nos. 3 and 4. Salem, Mass.—This new and valuable magazine fully sustains the character predicted for it, and realized in its first number. Its leading articles are of a popular character and such as to be read with interest, and understood by all classes, while its scientific miscellany, and correspondence, reports of the meet-

ings of Scientific Societies, etc., make it indispensable to every naturalist. Its illustrations are of a character rarely equalled in similar works.

No. 3, contains, Some Errors Regarding the Habits of Our Birds, by T. M. Brewer, M.D.; the Food of the Sea Urchin, J. W. Dawson, LL.D.; the Royal Families of Plants, C. M. Tracy; the Moss Animals, or Fresh Water Polyzoa, A. Hyatt; the Tarantula Killers of Texas, G. Lincecum; the Birds of Spring, J. A. Allen; the American Silkworm, L. Trouvelot; the Land Snails of New England, E. S. Morse; Reviews, Natural History Miscellany, etc.

No. 4, contains, The Recent Bird Tracks of the Basin of Minas, C. F. Hartt; the Habits of the Gorilla, W. Winwood Reade; the Moss Animals or Fresh Water Polyzoa, concluded; the Land Snails of New England, continued; Parasitic Plants, G. D. Phippen; Oyster Culture, F. W. Fellowes; the Scorpion of Texas, G. Lincecum, M.D.; A note from the far North (Russian America), J. T. Rothcock; etc.

4. *Tables for Qualitative Chemical Analysis;* Professor HEINRICH WILL of Giessen, Germany. Seventh edition, translated by Charles F. Himes, Ph.D., Professor of Natural Science, Dickinson College, Carlisle, Pa. Philadelphia, Henry C. Baird, 1867.—Professor Will's analytical tables have, in the earlier editions, become familiar to American students through Faber's translation. They furnish, undoubtedly, the most compact classification of reactions yet published. Dr. Himes's translation being from the seventh German edition, is considerably improved. He proposes it as a suitable text book for laboratory instruction in those colleges who are assigning to Natural Science a more prominent place in their courses of study. The book is convenient in size (octavo), and is published in good style.

5. *The American Annual Cyclopedia and Register of Important Events of the year* 1866, embracing Political, Civil, Military and Social affairs, Public Documents, Biography, Statistics, Commerce, Finance, Literature, Science, Agriculture, and Mechanical Industry. Volume VI, 796 pp., large 8vo. New York, 1867. (D. Appleton & Co.)—Appleton's Annual Cyclopedia is a very important contribution toward the political, civil and geographical history of this and other countries, and also is full of valuable articles in the various other departments which it aims to have represented. The volume for 1866 has a portrait of the King of Prussia as its frontispiece, and beyond, others of Bismarck and Garibaldi.

6. *Eaton's Arithmetic and the Decimal System.*—Prof. H. A. NEWTON, who has been among the foremost in labors to secure the introduction of the decimal system into the United States, has prepared an admirable chapter on the subject, as an addition to a new edition of Eaton's Arithmetic. It occupies pages 337 to 348 of the arithmetic, and consists of tables, explanations, and examples, all of which are well adapted to introduce the subject to the student and make him practically familiar with it. In view of the recent act of Congress with regard to the decimal system, this department of arithmetic ought at once to make a part of all the text-books used in the schools of the country.

7. *Micro-chemistry of Poisons, including their physiological, pathological and legal relations:* adapted to the use of the medical jurist, physician, and general chemist; by THEO. G. WORMLEY, M.D., Professor of Chem-

istry and Toxicology in Starling Medical College. and of Natural Sciences in Capital University, Columbus, O. xxxi, and 668 pp., 8vo, with 13 steel plates. New York, 1867. (Ballière Brothers).—Dr. Wormley has taken up the subject of poisons after a method wholly his own and has prepared a work of the highest merit, and practical utility. This volume treats first of the effects of poisons and the causes modifying them, the sources of evidence in cases of poisoning, and the methods of chemical analysis; and then proceeds to the special consideration of individual poisons, first the inorganic and then the organic. The new feature in his treatment of the subject consists in the use of the microscope for the study of the crystallizations resulting from the action of various reagents on the several poisons. The facts given are all from his own minutely careful experiments, and the results are exhibited with great perfection and delicacy on a series of plates from steel containing seventy-eight illustrations. The engravings are from the pencil and graver of Mrs. Wormley, and the artist, although but a novice in the latter art, has evinced that in such work she has no superior. We know not which to admire most, the masterly manner in which Dr. Wormley has treated his subject, the science of poisons, or the extreme beauty of the plates which supplement the text. The real practical value of the work the writer has already tested in connection with a case of poison by strychnine which he has now on hand. The Messrs. Ballière have issued the work in elegant style well comporting with its scientific merits. G. F. B.

8. *Chemistry of the Farm and the Sea, with other familiar Chemical Essays*; by Jas. R. Nichols, M.D. Boston, A. Williams & Co., 1867, 123 pp.—This volume includes nine chapters on the chemistry of the farm, the sea, a bowl of milk, the dwelling, a kernel of corn, obscure sources of disease, local decomposition in lead aqueduct pipes, bread-making, and the sun. It is an interesting book and will serve a useful purpose in popularizing science, though it is marred somewhat by inflation of style and errors of treatment.

9. *Annual Report of the Trustees of the Museum of Comparative Zoology, together with the report of the Director*, 1866.—This, the eighth annual report, shows continued activity in increasing the already vast collections of the museum. The Director's Report contains a general statement of the present condition of the museum, and a somewhat detailed account of his Brazilian Expedition and its important results.

10. *The Art of Perfumery and the Methods of obtaining the Odors of Plants*, with Instructions for the manufacture of perfumes for the handkerchief, scented powders, odorous vinegars, dentifrices, pomatums, cosmetics, perfumed soap, etc., to which is added an Appendix on preparing artificial fruit-essences, etc.; by G. W. Septimus Piesse, Analytical Chemist. 2nd American from the 3d London Ed. 402 pp., 12mo. Philadelphia, 1867. (Lindsay and Blakiston.)

11. *The Art of Manufacturing Soap and Candles*, including the most recent discoveries, embracing all kinds of ordinary hard, soft, and toilet soaps, especially those made by the cold process, the modes of detecting frauds, and the making of tallow and composite candles; by Adolph Ott, Ph.D., Practical and Analytical Chemist. 194 pp., 12mo, with wood-cuts. Philadelphia, 1867. (Lindsay & Blakiston.)

The two volumes whose title pages are here cited are popular and practical works on the subjects of which they treat. The first dips somewhat into the history and esthetics of the art, as well as its science.

12. *Notice of Volume IV of the Paleontology of New York;* by JAMES HALL. 24 pp., 18mo. Published March, 1867.—We have barely space to announce the appearance of this pamphlet, just now received. It contains a brief statement of some of the views and facts which are contained in the forthcoming *fourth* volume of the Paleontology of New York, with lists of the species described. The limits and characteristics of several genera of Brachiopoda are discussed, and some points are illustrated by figures.

13. *Ueber die Verschiedenheit in der Schädelbildung des Gorilla, Chimpansé, und Orang-Outang, vorzüglich nach Geschlecht und Alter, nebst einer Bemerkung über die Darwinsche Theorie;* von Dr. TH. L. BISCHOFF, Professor der Anatomie und Physiologie in München. Mit 22 lithographirten Tafeln. München.—This work will be valuable to those engaged in the study of the Quadrumana, and especially to those interested in the comparison of their anatomy with that of man. The plates are of folio size, and admirably executed.

The part of the work which possesses most general interest, is of course the appended note on the Darwinian Theory? Some of the points are as follows.—The assertion so confidently brought forward that the anthropoid apes are the direct ancestors of man, is entirely unsupported by evidence; moreover it is even contrary to the Darwinian theory rightly understood, for the extinction of the parent form is the direct consequence of the development of an improved form. The great problem of organic nature is twofold: 1. The origin of the simplest original forms; 2. The causes and the mode of their operation, by which more perfect forms were developed. A great defect of Darwin's theory is that he leaves the first question unanswered. Admitting that certain organisms must have been created, what right has he to say that other organisms may not have been created at intervals, even to the present time? Another defect of the Darwinian theory is, that no cause is assigned for the commencement of variation. To say that organisms have at once the power of transmitting peculiarities by inheritance, and of spontaneously originating variations, is a contradiction in terms. Darwin's treatment of the second half of the second question is more successful. Natural selection and the struggle for life must henceforth be fundamental principles in any theory of development. Since no general cause is assigned either for the origin of life or for the commencement of variation, all that can be considered as proved is that certain forms have been produced by variation from certain other forms. The facts warrant no general induction. We must be very cautious in accepting plausible theories without sufficient proof. The vagaries of the "naturphilosophie" furnish an instructive example. The psychical difference between man and brute is not merely quantitative, but qualitative. The distinctive peculiarity of man may be designated as *self-consciousness* (selbstbewusstsein), or the faculty of making one's self and one's mental condition a distinct subject of thought. On this faculty depend other important peculiarities of man, viz., the capability of indefinite progress, the idea of morality, the notion of a future state, and the power of language.

14. *L'Unita delle Forze Fisiche Saggio di Filosofia Naturale.* Del P. ANGELO SECCHI, D.C.D.G. 511 pp., 8vo. Roma, 1864.—The principal object of this work, as stated by the author, is to present to Italian readers an adequate representation and exposition, in their own language, of the modern doctrine of the unity or convertibility of natural forces, and of the principle of conservation of energy. The style is professedly adapted to the comprehension of the majority of readers, especially for those not deeply versed in science. But though, for this reason, divested of the appearance of abstruseness, and free from difficult mathematical investigations, it is not, in the proper sense of the word, a *popular* treatise. Important modern discoveries and theories are very fully cited, and everywhere the work bears evidence of extended research, and a wide acquaintance with the literature of modern science. Though there is little that is absobutely new in it, the book is valuable and interesting, being as it is an able exposition of principles which may almost be called the corner-stone of modern physics. There is probably no book in which the subject is more fully and satisfactorily treated than in this. The author appears to us to do but scant justice to Mayer, to whom the whole subject is so deeply indebted; for he does not even mention him in the preface, where are cited the names of those who have contributed most to this branch of science, and he makes subsequently but slight reference to his discoveries. A. W. W.

15. *Carte Hydrologique du Département de la Seine*, publié d'apres les ordres de M. Hausmann, Préfet de la Seine, et executée sur la carte topographique de l'Ingénieur des Ponts et Chaussées, par M. DELESSE, 1862, 4 sheets.—This admirable map represents, as its title indicates, all the natural and artificial water-courses of Paris and its vicinity. The basis of the map is the topographical survey by Letellier and Potiquet, officers of the department of des Ponts et Chaussées. Its scale is 1:25,000. The curves of equal elevation are given at intervals of four meters. The map is tinted according to the geological formations. On a map of this character all the drainage by rivers, rivulets, sewers, gutters, etc., is accurately given. The execution of the work is excellent, and its practical importance is very great.

16. *Memorie dell' Observatorio dell Collegio Romano;* Nuova Serie, vol. II, dall' anno 1860 al 1863, Pubblicate dal P. Angelo Secchi, della Compagnier di Gesu, Direttore, etc. Roma, 1863. 4° (16 numbers), pp. 128.—This volume contains the astronomical observations made at the Collegio Romano during the period indicated in the title. The principal subjects are the Comets II 1861 and III 1862, the solar eclipse of July 18th, 1860, and spectral analysis of the light from the heavenly bodies. With these is given also a memoir upon the connection between meteorological varieties and those of terrestrial magnetism.

Diagrams are given representing the appearance of the two comets, of the solar eclipse, of the planets Jupiter, Mars and Saturn, and of about twenty spectra of the planets and fixed stars.

The relations of the second of these comets to the August meteors makes the numerous representations of its telescopic appearance of special interest.

17. *Quelques vües generales sur les Variations Séculaires du Magnétisme terrestre*, 1er Fascicule, par V. RAULIN. 8vo, pp. 92. Extrait des Actes de la Société Linnéenne de Bordeaux; t. xxvi, 1867.—The author

gives a large number of observations showing the secular variations of the magnetic needle in all parts of the earth. He explains them by a hypothesis similar to that proposed in this Journal, xxxviii, 69, 1840, by the late Chancellor Lathrop. Mr. Raulin supposes that a body of greater density than the fluid portion of the earth, more or less irregular in form, and having the properties of a magnet, forms part of the earth's mass, but is not attached to the external crust. The line joining the poles of this magnetic mass is directed along the chord that joins the actual magnetic poles of the earth. This mass does not rotate exactly with the earth's crust, but falls behind it one revolution in about 600 years.

18. *Annales Météorologiques de l'Observatoire Royal de Bruxelles;* publiés, aux frais de l'état, par le directeur A. Quetelet, 4°, première Année, 1867, Nos. 1–5 (Jan.–May).—These annals give, in 8 quarto pages for each month, observations at Brussels of the barometer and thermometer for 15 stated hours each day, with maxima and minima, observations of August's psychrometer four times a day, of Osler's anemometer 12 times a day, of the direction of the wind, the state of the sky, and the declination of the needle four times a day, and of the electricity of the air, and the amount of rain daily.

19. *The Laboratory:* a weekly record of scientific research. London. (James Firth.)—We have now received the 13th issue of this active little journal and find that it increases in value with every number. Originated to provide a more efficient means of interchange in thought between men of science, especially chemists, it has brought to the task men of the first ability; and now we see it announced that Prof. Kekulé has consented to contribute regularly to its pages. We commend "The Laboratory" to the notice of men of science, confident that the papers published in each number are well worth the price of subscription.

20. *The Record of Zoological Literature for* 1865. Vol. II. 798 pp. 8vo. Edited by Dr. Albert C. L. G. Gunther. (London, John Van Voorst).—A book almost indispensable for every working Zoologist.

21. *Chambers's Encyclopedia.*—The American edition of this important Encyclopedia, issued by Lippincott & Co., Philadelphia, has reached Part 115, which nearly finishes the letter T.

Mining and Metallurgy of Gold and Silver; by J. Arthur Phillips, Mining Engineer, Graduate of the Imperial School of Mines of France, &c. 8vo. Preparing for publication. (E. & F. N. Spon, London; J. Wiley & Son, New York.)

Notes upon the Geology of some portions of Minnesota, from St. Paul to the western part of the State; by James Hall. 12 pp., 4to. From the Trans. Amer. Phil. Soc., vol. xiii, 1867.

On the Distribution of Temperature in the lower region of the Earth's atmosphere; by Henry Hennessy, F.R.S., Prof. Nat. Phil. in the Catholic Univ. of Ireland. 58 pp., 4to, with a folded plate. Dublin, 1867. From the Trans. Roy. Irish Acad., vol. xxiv.

Proceedings Acad. Nat. Sci. Philadelphia, No. 1, Jan., Feb., March, 1867.—p. 2, On a new genus of Homoptera; *H. Skinner.*—p. 11, On some points in the Mammalian skull; *H. Allen.*—p. 13, On Itacolumite; *C. M. Wetherill.*—p. 15, On colonies of plants observed near Philadelphia; *A. H. Smith.*—p. 24, The Cutting Ant of Texas; *G. Lincecum.*—p. 31, Notice of a fossil skull of a large Turtle from the Cretaceous of New Jersey, Euclastes platyops; *Cope.*

Proceedings Bost. Soc. Nat. Hist., Vol. XI.—p. 71, Analysis of Meteoric iron of Colorado; *C. T. Jackson.*—p. 75, Diatoms of a deposit near L. Winisquam, in Laconia, N. H.; *R. C. Greenleaf.*—Diatoms of the White Mts., the minuteness, etc.; *C. Stodder.*—Infusorial Earth from Peru; *C. Stodder.*—p. 79, Diatoms and other microscopic objects of the Gulf of Mexico; *R. C. Greenleaf.*

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. XIV.—*On Mineralogical Nomenclature;* by James D. Dana.

No. I. *On System in Mineralogical Nomenclature.*

Mineralogical nomenclature had already a commencement of system among the old Greeks and Romans; and this system was the same as that of the modern science. It consisted in adding to the word signifying a quality, constituent, use, or locality of the stone, the termination *ites* or *itis;* and although, through the many ways in which names were originated and the absence of any scientific purpose, those of other kinds are numerous, this was the common method of forming names for objects in inorganic nature.

The following are a few examples, from Pliny's Natural History.

1. *Names derived from physical characters.*

Hæmatites, from *ἅιμα*, *blood*, in allusion to the color of the powder.
Steatites, from *στέαρ*, *fat*, in allusion to the greasy feel.
Pyrites, (including millstones, as well as our pyrites, etc.) from *πῦρ*, *fire*, because supposed to have a peculiar affinity for fire, as shown by the sparks given out when struck.
Rhoditis, from *ῥόδον*, *a rose*, in allusion to the color.
Chloritis, from *χλωρός*, *green*, in allusion to the color.
Ceramitis, from *κέραμος*, a tile, or earthenware, from the color.
Ceritis, from *κηρός*, *wax*.
Iritis, from rainbow-like reflections.
Phengites, from *φέγγος*, *brightness*, in allusion to the transparency.
Selenitis, from *σελήνη*, *the moon*, in allusion to its reflections.
Molochitis (our Malachite) in allusion to its green color, from the Greek for the Mallow.

Porphyrites, from *πορφύρα*, *purple.*
Prasites—*πρασίτης* of Theophrastus, from the leek-green color.
Crateritis, from *κρατερός*, *strong*, in allusion to the hardness.
Anthracitis, for a stone resembling coal in being black and yielding a black color when rubbed on a whetstone; also for another kind which resembled a burning coal.
Ophites, for stones having streaks of green color, like serpents.

2. *Names having reference to the form of the stone.*

Ostracites, for fossil shells.
Ostritis, a fossil oyster shell, or related species.
Phenacites, for stones resembling a date.
Botryites, " " a bunch of grapes.
Phycites, " " a seaweed, from *φυκος*, *a seaweed.*
Scorpitis, " " a scorpion in color or shape.
Dendritis, " " a tree.

3. *Names derived from the uses of the mineral.*

Alabastritis, for the stone (mostly, if not wholly, stalagmite) from which the kind of vase called *alabastron* was made.
Chrysites, from *χρυσός*, *gold*, it being used in trials for gold.
Basanites, from *βάσανος*, *a touchstone.* .

4. *Names having reference to the constitution of the stone.*

Chalcitis, from *χαλκός*, *copper* or *brass*, for a copper ore.
Sideritis, from *σίδηρος*, *iron.*
Chrysitis (from the Greek for *gold*), Argyritis (from the Greek for *silver*), and Molybditis (from the Greek for *lead*), were names of products obtained in the reduction of silver ores; the first is supposed to have been a yellow litharge.

5. *Names derived from the names of localities.*

Pharanites, from the name of a locality in Arabia.
Syrtites, from a locality on the shores of the Syrtes.
Choaspitis, from a locality on the river Choaspes.
Syenitis, from Syene, in Egypt—probably the red Syenite of Syene.
Memphites, from Memphis in Egypt—a kind of marble.

The termination *ites* or *itis* was thus distinctive of the names of minerals, stones, or fossils.[*] Moreover, the names were derived from qualities, forms, uses, and localities, or from the same characteristics that are now referred to in making the new names of the science. The only modern kind of name not in vogue in Pliny's time is that *after persons.*

Werner appears to have been the first to introduce this class of names into Mineralogy. The earliest example, if I mistake not, was that of naming what de Born had called *Green Mica* (Mica viridis) *Torberite,*

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[*] This termination does not come from the Greek word λίθος, *stone*, for this word when in composition retains in Latin names (and also in the modern German) its original form, as in *Chrysolithus.*

after its investigator, the chemist Torber Bergmann (more correctly written *Torbernite* by some mineralogists of last century, as Bergmann, wrote his name in Latin, the language of his scientific works, Torbernus Bergmann). The name encountered objections; and Werner, in view of Bergmann's announcement (after some incorrect trials) that the mineral was a *copper* ore, substituted in 1789 the name *Chalcolite.* He however, immediately afterward (early in 1790) showed that he saw nothing bad in the style of name by designating other new species *Prehnite* and *Witherite*, the former after Col. Prehn the discoverer, and the latter after Dr. Withering the discoverer and analyst of the species. The same year, Estner, a mineralogist of Vienna, issued a pamphlet against the Werner school, with the title "Freymüthige Gedanken über Herrn Inspector Werner's Verbesserungen in der Mineralogie," etc., (64 pp. 16mo, 1790), in which he makes light of Werner's labors in the science, and under the head of *Prehnite* ridiculed this method of creating a paternity, and providing the childless with children to hand down their names to posterity (p. 25). Such names were, however, too easily made, too pleasant, as a general thing, to give and receive, and withal too free from real objection, to be thus stopped off, and they have since become numerous, even Vienna contributing her full share toward their multiplication.

As a part of the history of mineralogical nomenclature, it may be here added that Werner, when it was proved that his *chalcolite* was an ore of uranium with but little copper, instead of a true ore of copper, dropped the name entirely, and called the mineral simply *Uranglimmer* (Uranium mica); and Karsten, in his reply to Abbé Estner (Berlin, 1793, 80 pp. 12mo), makes out of the necessary rejection of chalcolite an argument against chemical names, and in favor of names after persons, as the latter could never turn out erroneous in signification.

During the Middle ages many provincial names for stones and ores originated, or came into use, in the mining regions of Europe; and some of these have since had general acceptance, such as Quartz, Blende, Hornblende, Talc, Feldspar, Schorl, Mispickel, Copperas (from Kupferwasser of the Germans, like Couperose of the French[*]).

In the course of the last century, when the science of minerals was taking shape, and progress in chemistry was helping it forward, there was an effort, on one side, to introduce, under the influence of Linnæus, the double names of other branches of Natural History; and, on the other, under the influence of Cronstedt and Bergmann, names expressive of chemical composi-

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[*] The German word Kupferwasser, literally signifying Copper-water, (the *Chalcanthum*, and *Atramentum sutorium* of Pliny,) included the different vitriols, whether in solution or crystallized, which are a common result of the alteration of copper and iron pyrites and blende. Both the copper and iron pyrites passed for copper ores among the older miners from the Greeks down, and they occur mixed together along with blende in most mining regions. The words *couperose* and *copperas* have been supposed to come from the Latin *cuprirosa.* But *cuprum* gave *cuivre* to the French, and it is hardly a possibility that the Latin *u* should in another case, or ever, have become changed to the French *ou* instead of the sharp *u*; while the German *u* would naturally take this form.

tion as far as it was ascertained; and the two methods have had their advocates till late in the present century. But, at the same time, the necessity of single names was recognized by most of the early mineralogists; and in the spirit of the system which had made its appearance among the Greeks and Romans out of the genius of the Greek language, they almost uniformly adopted for the new names the termination *ite*.

Thus we have from Werner the names Torberite, Chalcolite, Graphite, Prehnite, Witherite, Boracite, Augite, Pistacite, Pinite, Aragonite, Apatite, Leucite, Cyanite (Kyanite); and from other sources in the same century, Zeolite, Actinolite, Tremolite, Coccolite, Arendalite, Baikalite, Melanite, Staurolite, Lepidolite, Cryolite, Chiastolite, Collyrite, Agalmatolite, Sommite, Moroxite, Pharmacolite, Strontianite, Delphinite, Titanite, Ceylanite, Gadolinite, Rubellite, Sahlite, Wernerite, Scapolite, Mellite, etc.

The termination *ine*, was also adopted for a few names, as Tourmaline, Olivine, Mascagnine, Serpentine; and *an* in Vesuvian; but the great bulk of the names were systematically terminated in *ite*.

With the opening of the present century (in 1801), Haüy came forward with his great work on Crystallography, and in it he brought out a variety of new names that defy all system, having nothing of the system of the earlier science, and no substitute of his own. Forgetting that the unity of law which he had found in nature should be a feature of scientific language, he gave names to minerals as a gardener might to his varieties of pinks and roses, introducing thus the terminations—

ane, in Cymophane;
ase, in Euclase, Idocrase, Anatase, Dioptase;
aste, in Pleonaste;
age, in Diallage;
ene, in Disthene, Sphene;
gene, in Amphigene;
ide, in Staurotide;
ime, in Analcime;
ole, in Amphibole;
ome, in Aplome, Harmotome;
ose, in Orthose;
ote, in Actinote, Epidote;
yre, in Dipyre;
ype, in Mesotype.

And the true mineralogical termination *ite* he admitted only in the few following: Axinite, Meionite, Pycnite, Stilbite, Grammatite.

Haüy had commanded so great and so general admiration by his brilliant discoveries in crystallography, and by the benefits which he had thus conferred on mineralogical science, that his names with their innovations were for the most part immediately accepted even beyond the limits of France, although a number of them were substitutes for those of other authors.[*] Some of Werner's names were among the rejected; and a break was thus occasioned between German and French mineralogy, which will not be wholly removed until the rule of priority, properly restricted, shall be allowed to have sway.

Beudant succeeded Haüy, and had the same want of system in his ideas of nomenclature. Finding occasion to name vari-

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[*] The *substitutes* among the above names in the 1st edition of Haüy's Crystallography (1801) are the following;

Amphibole, for *Hornblende* of last century and earlier.

Orthose, for *Feldspar*.

Pyroxene, for *Augite* of Werner, and *Volcanite* of Delamétherie. [Delamétherie was a contemporary of Haüy at Paris, the author in 1792 of an edition of Mongez's *Manuel du Minéralogiste* (after Bergmann's Sciagraphia); in 1797, of an ambitious speculative work entitled *Théorie de la Terre*, the first two volumes of which consisted of a Treatise on Mineralogy; in 1811, 1813, of *Leçons de Minéralogie*, in 2 vols., and for a number of years principal editor of the *Journal de Physique*. He gave offense to Haüy by some of his early publications. Haüy's mineral Euclase is described in full by Delamétherie in the *Journal de Physique* for 1792 (some years in advance of Haüy's description of it,) without crediting the name or anything else to Haüy: but five years later, in his *Théorie de la Terre*, he inserts the species with full credit to Haüy.]

Cymophane, for *Chrysoberyl* of Werner.

Idocrase, for *Vesuvian* of Werner.

Pleonaste, for *Ceylanite* of Delamétherie.

Disthene, for *Kyanite* (Cyanite) of Werner.

Anatase, for *Octahedrite* of de Saussure, and *Oisanite* of Delamétherie.

Sphene, for *Titanite* of Klaproth.

Nepheline, for *Sommite* of Delamétherie.

Triphane, for *Spodumene* of d'Andrada.

Amphigen, for *Leucite* of Werner.

Actinote, for *Actinolite* of Kirwan, and *Zillerthite* of Delamétherie.

Epidote, for *Thallite* of Delamétherie, *Delphinite* of de Saussure, and *Arendalite* of Karsten.

Axinite, for *Yanolite* of Delamétherie.

Harmotome, for *Andreolite* of Delamétherie.

Grammatite, for *Tremolite* of Pini.

Staurotide, for *Staurolite* of Delamétherie, and *Grenatite* of de Saussure.

And, later, *Paranthine*, for *Scapolite* of d'Andrada, and *Rapidolite* of Abildgaard.

Part of the changes were made with good reason. But others were wholly unnecessary. Haüy was opposed to names from localities, and hence several of the displacements. He objected also to names based on variable characters, and characters not confined to the species. Moreover, as his pupil, Lucas, observes (in giving reasons for rejecting the name *Scapolite* and substituting *Paranthine*,) "le vice du mot *lite*, qui s'applique à toutes les pierres, ne pouvoient plus convenir à cette substance du moment où elle seroit reconnue pour une espèce." Haüy's own names are remarkable, in general, for their indefiniteness of signification, which makes them etymologically nearly as good for one mineral as another, and very bad for almost none; as for example, *Diallage*, which is from the Greek for *difference; Analcime*, from *weakness* in Greek; *Orthose*, from *straight* in Greek; *Epidote*, from *increase* in Greek; *Anatase*, from *erection* in Greek, interpreted by him as equivalent to *length; Idocrase*, from *I see mixture* in Greek, etc. His name *Pyroxene*, which he defines *hôte ou étranger dans le domaine du feu*, is an unfortunate exception, as often remarked, the mineral being the most common and universal constituent of igneous rocks. It was a bad substitute for *Volcanite* of Delamétherie, and looks as if Haüy's adoption of it might have been prompted by repugnance to Delamétherie.

ous mineral species which till then had only chemical names, he adopted Haüy's method of miscellaneous terminations, but indulged in it with less taste and judgment, and with little knowledge of the rules of etymology. In his work we find the termination *ese*, in Apherese, Aphanese, Neoctese, Acerdese, Mimetese; *ise*, in Leberkise, Sperkise, Harkise, (only German words Gallicized,) Melaconise, Zinconise, Crocoise, Stibiconise, Uraconise; *ose*, in Argyrose, Argyrythrose, Psaturose, Aphthalose, Rhodalose, Siderose, Elasmose, Exanthalose, Cyanose, Melinose, Disomose; *ase*, in Neoptase, Discrase; *ime*, in Ypoleime; *ele*, in Exitele; while names ending in *ine* are greatly multiplied.

With a little better knowledge of classical rules he would not have retained the terminal *s* of the Greek in the derivative, and thus have made the intolerable names above which end in *ose* and *ese*, and in part in *ise* (as *Siderose* from σίδηρος, *Aphanese* from ἀφανής, *Melaconise* from μέλας, *black*, and κόνις, *powder*); and with more of the spirit of system, he would have rejected entirely the plan of miscellaneous terminations.

In Germany, the tendency has always been to uniformity through the adoption of the termination *ite*. Breithaupt has been somewhat lawless, giving the science his Plinian, Alumian, Sardinian, Asbolan, etc.; his Castor and Pollux (no doubt regarded as a good joke, though in our view a joke out of place); his Glaucodot, Homichlin, Orthoclase, Loxoclase, Xanthocon, etc.; still, far the larger part of his numerous names are rightly terminated.

In view of the above and other considerations, we arrive at the following conclusions:—

1. The only chance for uniformity in mineralogical nomenclature is in the general use of the termination *ite*.

2. This termination is the best that is available, because of (1) its original use and signification, (2) its early origin, (3) its almost universal adoption in the science.

3. If any other termination in addition is to be used, it should be so only *under system;* that is, it should be made characteristic of a particular natural group of species, and be invariably employed for the names in that group; and its use should not be a matter of choice or whim with describers of species.

As a matter of fact, *ine* has not been employed for any particular division of minerals, or with reference to any system, and it could not now be so restricted; and, this being the case, it should be put out of the science as far as possible. It belongs by adoption and long usage to chemistry, and should be left to that science.

4. In order that the acquired uniformity may be attained, changes should be made in existing names, when it can be done without great inconvenience.

Names like *Quartz*, *Garnet*, *Gypsum*, *Realgar*, *Orpiment*, with the names of the metals and gems, which are part of general literature, must remain unaltered. *Mica* and *Feldspar*, equally old with Quartz, have become the names of *groups* of minerals, and are no longer applied to particular species.

Fluor was written *Fluorite* last century by Napione. *Blende*, although one of the number that might be allowed to stand among the exceptions, has already given place with some mineralogists to *Sphalerite*, a name proposed by Haidinger (because blende was applied also to other species) in 1845, and signifying *deception*, like Blende. Galena was written *Galenite* by von Kobell some years since. Orthoclase, Loxoclase, Oligoclase might be rightly lengthened to *Orthoclasite*, etc. But the termination *clase* (from the Greek for *fracture*) is peculiar to names of minerals, and the abbreviated form in use may be allowed to stand for species of the Feldspar group. It seems better that it be avoided elsewhere. These remarks on special cases might be further extended; but it is unnecessary as I shall soon present my views more fully in another place.

There are of course objections to all such change. But the number of names requiring it are comparatively few; and hardly any of them are over sixty years old—a short time compared with the future of the science. Mineralogy is yet in its formative period; it is far from being so stiffened with age as not to admit of progress in the direction contemplated.

It has become very desirable that the nomenclature of rocks should have some point of difference from that of minerals. Names, like Diorite, Dolerite, Eurite, Porphyrite, Andesite, Tonalite, Phonolite, Leptynite, Domite, Dunite, Amphibolite, Pyroxenite, Pegmatite, Hyperite, Itacolumite, Spilite, Ditroïte, Sanidinite, Phthanite, Nephelinite, Miascite, Itabirite, Aphanite, are fast multiplying, and have nothing in them to indicate whether they are to be looked for or not in a work on mineralogy. It is, therefore, here suggested, as an easy method of giving the names of rocks a distinctive feature, to substitute for *i* in the final *ite* the letter *y*. Thus Diorite, Eurite, Tonalite, etc. would become Dioryte, Euryte, Tonalyte, etc. The *y* is already in the name *Trachyte*. The change would not be necessary in the familiar names Granite and Syenite. In the German language the terminal syllable *lite*, when from the Greek λιθος, is written *lith*, as in *Phonolith*; but it would be no disadvantage to the language, or to its science, if the *h* should be left off here as elsewhere, and the *yte* (or *yt* in German) be accepted as simply a termination in obedience to system.

In another paper I propose to discuss the bearing and limitations of the law of priority in mineralogical nomenclature.

ART. XV.—*Observations and Experiments on living Organisms in heated water;* by JEFFRIES WYMAN, M.D., Hersey Professor of Anatomy in Harvard College.

IN a former number of this Journal (vol. xxxiv, July, 1862), an account was given of some experiments on the formation of Infusoria in boiled solutions of organic matter, the result of which was, that such solutions, exposed only to air which had passed through iron tubes heated to a redness, became the seat of infusorial life. The same result followed when similar solutions were enclosed in hermetically sealed flasks, and subsequently exposed to the action of boiling water. In a few instances Infusoria appeared when the temperature was raised above 212° F. All living beings found under the above circumstances have been attributed either, 1st, to organisms or the germs of them, supposed to be contained in the fluid experimented with, or the air included in the flasks; or 2d, to the direct transformation of organic matter into new living beings, independently of any germs or living organisms whatever; or in other words to "spontaneous generation."

Abundant proof has been brought forward to show that the spores or germs of infusoria exist in the air in quantities amply sufficient to account for the presence of living organisms in solutions freely exposed.

There can therefore be no certainty of the existence of spontaneous generation in a given solution, until it can be shown, that this has been freed of all living organisms which it contained at the beginning of the experiment, and kept free of all such from without during the progress of it. On the other hand, this kind of generation becomes probable, whenever it is made certain that Infusoria do appear in solutions, in which the conditions just mentioned have been complied with.

We say probable, because their appearance under such circumstances would not amount to a proof. The absolute proof of spontaneous generation must come from the formation of living organisms out of *inorganic* matter. If infusoria are generated in solutions of organic matter, independently of spores or germs, the question may be fairly raised whether we do not begin the experiment with materials in which life already exists, even though this material is not in the form of distinct organisms.

The issue between the advocates and the opponents of this doctrine, clearly turns on the extent to which it can be proved that living beings resist the action of water at a high temperature, or on what Pouchet calls "vital resistance," for in nearly all the observations hitherto made, heated water has been the agent for the destruction of infusorial life preliminary to the beginning of an experiment.

The observations and experiments contained in this communication, have not been brought together either for sustaining or refuting the doctrine just referred to, but partly with the view of testing the accuracy of the experiments formerly made, and chiefly for the purpose of determining how far the life of certain kinds of low organisims is either sustained or destroyed in water which has been raised to a high temperature, a result which must be reached before spontaneous generation can be either asserted or denied. The evidence which will be adduced is derived from the following sources:

1st, from the phenomena of hot springs;

2d, from the appearance or non-appearance of Infusoria in solutions boiled for different periods of time, and exposed only to pure air;

3d, from the observed action of heat on the living organisms which the solution experimented with, was known to contain.

SECTION I. *Thermal Springs.*—The study of organisms living in thermal waters is of great importance in connection with the investigation of the limit of vital resistance. Having become adapted, through a long series of years, to their surroundings, such organisms may be supposed to live under circumstances the most favorable possible, for sustaining life at a high temperature. It is a well known physiological fact that living beings may be slowly transferred to new and widely different conditions without injury; but if the same change is suddenly made they perish. In the experiments made in our laboratories, the change of conditions is relatively violent and therefore liable to destroy life by its suddeness, when otherwise it might possibly have been sustained. In the thermal waters therefore which give us a range of temperature as high as 212° F., we are more likely to find the highest degree of heat consistent with the maintenance of life than in our flasks. The following accounts from different observers have been selected as giving the highest temperature at which life has been noticed in hot springs. It must not be overlooked, however, that these have been thus far very imperfectly studied, especially with regard to the lowest organisms, and that we are by no means sure that the extreme limit of endurance in them has been ascertained.

Hot Springs of Luzon.—These springs were examined by Sonnerat[*] and his account of them is often quoted as evidence that they are inhabited by fishes and plants at a temperature of 187° F.[†] This assertion is not sustained by those who have visited them since Sonnerat. Dr. Abel who accompanied Lord Amherst in his mission to China examined them, and "saw no fish, but a

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[*] Journal de Physique, Avril, 1774, t. iii, p. 256.

[†] Spallanzani Opuscoli, Milano, 1826, p. 69.

small snake and a frog which were not only dead but boiled."* Marion de Procé, who has examined the same springs with care states that the waters where the fish were actually found did not exceed 36° C. (or 96·8° F.)* Prof. James D. Dana, one of the naturalists of the U. S. Exploring Expedition also visited them; he makes no mention of animal life, but gives the important observation "that the stones were covered with a white incrustation which appears to be silicoeus, and a species of feathery vegetation occurs also upon those bordering the streamlets where the temperature is 160° F., and presenting various shades of green and white.†"

Hot springs of the Ouachita.—These are situated in Hot-spring Co., Arkansas, and the four hottest are stated by Major Long to have the temperature of 132°, 140°, 148° and 150° F., respectively. He says "not only Confervæ and other vegetables grow in and about the hottest of them, but great numbers of little insects are constantly seen about the bottoms and sides." "A small bivalve testaceous animal adheres to the plants and lives in such a high temperature."‡

Hot springs of Sorujkund.—Dr. Joseph D. Hooker found in these springs *Confervæ* which Berkeley referred to the genus *Leptothrix* "growing on the margins of the tanks and in the hottest water; the brown is the best salamander, and forms a belt in deeper water than the green; both appear in luxuriant strata, wherever the temperature has cooled down to 168° F., and as low as 90°." §

The hot springs of Pugha, in Thibet reach the temperature of 174° F., and *Confervæ* and *Oscillatoriæ* were found growing in them by Capt. Strachey.‖

Hot springs of Mariara and La Trinchera.—Humboldt has given the result of his own carefully made observations on the thermal waters of South America, among the most remarkable of which are those of Mariara and La Trinchera, and of these the latter is the hottest. Of La Trinchera he says, "We were surprised at the luxuriant vegetation that surrounds the basin; *Mimosas* with slender pinnate leaves, *Clusias* and fig trees have pushed their roots into the bottom of a pool, the temperature of which was 85° C. (185° F.), and the branches of these trees extend over the surface of the water at two or three inches distant." "An *Arum* with a woody stem, and with large sagittate leaves, rose in the very middle of the pool, the temperature of which was 70° C. (158° F.) Plants of the same species vege-

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* Edwards, Influence of Physical Agents on Life. Translated by Dr. Hodgkin and Dr. Fisher. London, 1832, p. 466.

† Geology of the U. S. Exploring Expedition, p. 543.

‡ Long's Expedition to the Rocky Mountains, vol. ii, p. 291. Philadelphia, 1822.

§ Himilaya Journals, vol. i, p. 27. London, 1854.

‖ Ibid, vol. ii, p. 379.

tate in other parts of those mountains at the brink of torrents, the temperature of which is not 18° C. (64·4° F.)[*]

Hot springs of California.—I am indebted to Dr. William H. Brewer, Botanist to the Geological Survey of California, and to Mr. William T. Brigham of Boston for the information which follows, in relation to the thermal waters of this state which they have personally examined. Dr. Brewer's observations as will be seen by the following extract from his letter to me, show the existence of plants in water of a considerably higher temperature than even that of La Trinchera. He says, "the place where the greatest temperature was noticed, in which plants occur is the Geysers, in Lake (formerly Sonoma) county about seventy-five miles north of San Francisco. Vegetable forms flourished in these waters at various temperatures up to 93° C., (199·6° F.,) but were most abundant in waters of the temperatures of 52° to 55° C. (125°-131° F.)"

"At the higher temperature they were not abundant and existed as grains like Nostoc or Protococcus, intensely green and rather dark. They were observed in several cases where the water was above 90° C., but were more common in the streams, as the water cooled, and formed large slimy masses. Much of these were in long slender filaments like Confervæ."[†]

"The temperatures given here were carefully observed with a standard centigrade thermometer, with a naked elongated bulb."

Mr. Brigham visited the same springs and made a collection of some of the Confervoid plants growing in them. In regard to animal life he says, "although I looked with great care I could find no living animals in the water, but boiled insects were rather common. These were not fair cases, as the waters were so strongly impregnated with sulphur and acid that these alone might account for the absence of animal life. On the bank where the temperature ranged from 197° to 207° F., spiders were abundant and seemed to feel no inconvenience from the heat. I saw several feeding on the bodies of insects boiled by the water. The spiders were seen even standing on the water which was 176° F.; their bodies were not immersed and the hairs on the legs might, as is often the case, repel the water."

Hot springs of Iceland.—"Mr. Flourens exhibited to the Academy, Confervæ collected in Iceland by M. Descloizeaux who found them growing in the Gröf at a temperature of 98° C., or 208° F."[‡]

Many other accounts[§] of living organisms in thermal waters

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[*] Personal Narrative, Bohn's edition, London, 1852, vol. ii, p. 38.

[†] Since the above was written, Prof. Dana and Dr. Brewer have published in this Journal, 1866, vol. xli, p. 389, various observations and remarks in relation to life in hot springs and in high temperatures.

[‡] Comptes Rendus de l'Academie des Sciences, xxiii, 1846, p. 934.

[§] See Edwards, Influence of Physical Agents on Life, London, 1832, p. 407. Carpenter, Gen. and Comp. Physiology, Philadelphia, 1851, pp. 57 and 70.

might be given, but they relate mostly to a temperature lower than that of those already mentioned. Our object has been to bring together only the hottest, and with regard to which the evidence is trustworthy.

The statements we have quoted give satisfactory proof that different kinds of plants may live in water of various temperatures, as high as 168° F., as observed by Dr. Hooker in Sorujkund, 174° as observed by Capt. Strachey in Thibet, 185° as observed by Humboldt in La Trinchera, 199° as observed by Dr. Brewer in California, and 208° as observed by Descloizeaux in Iceland. The lowest forms only are found in the hottest waters.

With regard to animals the testimony is much less complete. The highest temperature at which they have been found, in so far as we have seen any evidence was, as stated by Major Long, 150° F., in the hot springs of the Ouachita where he found "bivalve testaceous animals" and insects. In the instance mentioned by Mr. Brigham, although the spiders were in air the temperature of which was from 197° to 207° F., it is doubtful whether their bodies were as hot. They are air-breathing animals, but it is not unlikely that the heat of their bodies is kept down as in others whose breathing is aerial by the evaporation from their respiratory and other surfaces. Otherwise it does not appear how the albuminous matter in their fluids is kept from coagulation. When walking on the surface of the water it is most probable, as Mr. Brigham suggests, that their feet are not immersed, but that these, as in Hydrometro, repel the water; the insects therefore might be wholly surrounded by air, in which case the temperature would be lower than that of the water. If a thermometer be held a short distance, not exceeding a half-inch, from the surface of boiling water, the temperature indicated will be many degrees below the boiling point. A marked difference exists even when the bulb and water nearly touch.

To show the importance of great accuracy in determining the temperature at the precise spot where the organisms are found we will cite the following statement, where a very erroneous result would have been obtained if the temperature of the surface-water had been taken as representing that of the whole mass. Tripier in his account of the baths of Hamman-mes-Koutin, in Algeria, saw fishes in water the surface of which had a temperature of 56° C. (132° F.), but in the lower layers from which the fishes did not rise, the thermometer indicated only 40° C. (104° F.) It is to be feared that this possible difference of temperature has not always been kept in view, by those who have reported the existence of animals in water of a high degree of heat.

Dr. Carpenter in his General and Comparative Physiology mentions several instances of animals living in a high temperature and also states, that "at the island of New Amsterdam there is a mud spring, which, though hotter than boiling water, gives birth to a species of Liverwort."[*] It is presumed that this is the island of the same name referred to by Humboldt, but he only states that the springs in question were much hotter than those of the Mariara, which last were from 132° to 135° F.[†] It has also been asserted that Humboldt saw living fishes thrown out from the crater of Chimborazo at 210° F., and that they have been discharged at a higher temperature from the Geysers of Iceland.[‡] In the first instance it was at Cotopaxi and not Chimborazo, that Humboldt made his observations. A species called *preñadillas* by the natives (*Pimelodus cyclopum*) is expelled from time to time from the crater, or clefts in the sides of it, in immense numbers; but he expressly states that the water expelled at the same time is not hot but cold and that the fishes are not so disfigured as to indicate that they had been exposed to a high temperature.[§] We have not been able to find authority for the statement with regard to the Geysers.

SECTION II. *Experiments with boiled solutions of organic matter in sealed flasks.*—These experiments, which are divided into two series, were made for the purpose of ascertaining to what extent certain kinds of organic solutions became the seat of infusorial life, notwithstanding a more or less prolonged exposure to boiling water, and the precautions taken to exclude the entrance of infusoria from without. They are in part repititions of some of those formerly described, the results of which they fully confirm. Great pains have been taken to ensure accuracy in conducting, as well as in observing and recording them.[‖]

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[*] Gen. and Comp. Physiol., 3d edition, Philadelphia, 1851, pp. 57 and 70.

[†] Humboldt's Personal Narrative, London, 1852, vol. ii, p. 24.

[‡] Bibliothèque Universelle de Geneve, tome xx, p. 204, 1839.

[§] Humboldt, Recueil d'Observations de Zoologie et d'Anatomie Comparée, 4to. Paris, 1811, p. 21.

[‖] M. Milne Edwards in referring to the former series of experiments reported by the writer of this article and to others similar to them, questions their accuracy, since they do not agree with those of M. Pasteur, and thinks the difference in the results depended upon a defective mode of conducting the experiments. The process employed in some of them was identical with that employed by M. Pasteur himself, and in others, with that made use of by M. Milne Edwards in his one experiment (see his *Leçons sur la Physiologie et l'Anatomie Comparèe*, t. viii, pp. 260, 269.) When flasks, holding organic fluids and air, are hermetically sealed and boiled for from fifteen minutes to three or four hours, and infusoria make their appearance nevertheless, the experiment cannot be called a faulty one, so long as only these results are claimed. The recent experiments of Dr. G. W. Child of Oxford, England, and those reported in this communication are a sufficient answer to the criticisms of M. Edwards. The experiment of Pouchet recorded in his *Nouvelles Experiences*, Paris, 1864, p. 224, is conclusive as to possibility of Infusoria appearing in boiled solutions exposed to pure air.

SERIES A. The flasks used in this series had a capacity of about 800 c. c. and had a long and slender neck; this was drawn out, about an inch from the end to a size which could easily be melted in a flame and in some instances the stem of a clay pipe, with a calibre of 0·08 inch, and in others, a copper tube 0·18 inch in diameter and filled with fine wires, was cemented into the mouth. The fluid in the flasks was boiled and thus the contained air expelled and replaced by steam. After the boiling had been continued sufficiently long, the whole was then allowed to cool slowly, the air to reënter through the tube, which last was kept meanwhile at a red heat. After the flask was cold it was hermetically sealed, the heat of the tube being carefully kept up until this was accomplished. Thus a boiled organic solution was obtained, in contact only with air which had been purified by heat.

Exp. I.—The contents of the flask were a few grains of meat and sugar, and 20 c. c. of water boiled 25 minutes. An infusorial film was formed on the 5th day; the flask was opened on the 31st. Vibrios were found in large numbers.

Exp. II.—50 c. c. of beef-juice and water were boiled twenty minutes. On the 4th day a thick infusorial film was formed over the whole surface of the fluid; the flask was opened on the 6th day and found to contain Vibrios and Bacteriums.

Exp. III.—The flask contained a small piece of beef weighing about three grammes, and 50 c. c. of water, which were boiled 30 minutes. An infusorial film was formed on the 3d day, which sank to the bottom and was afterwards replaced by another.

The flask was opened on the 27th day; the contents had a nauseous odor but were not putrid. The muscular fasciculi had fallen to pieces and the fluid had become slimy and viscid. Immense numbers of Monads filled the solution. Some feathery crystals were noticed, but the most striking circumstance in this as well as in some other instances in which muscle was used, was the fatty degeneration of the fibres which had taken place subsequently to the boiling. The fibres were found in many stages of change, some of them having their contents finely granular, striæ still seen, while others were filled with oil-globules, and had no traces of striæ left. One specimen was examined by Dr. Calvin Ellis who was unable to recognize any difference between the appearances which it presented and those of ordinary fatty degeneration of the muscles.

Exp. IV.—The flask contained very thin wheat paste mixed with saliva and water; the boiling was continued 25 minutes. No film was noticed until the 30th day, the flask was opened on the 68th day, and the fluid found filled with Monads.

Exp. V.—A few grains each of meat and sugar in 20 c. c. of water were boiled 25 minutes. An infusorial film appeared on the 4th day. The flask was opened on the 50th day by Prof. Henry James Clarke by whom the accompanying figures were carefully drawn from nature.

Fig. 1. *Vibrio baccillus*, enlarged two thousand diameters; these are very numerous and move quickly; the joints appear to be united by a gelatinous substance which is quite transparent and move on each other by a series of flexions and extensions; the number of segments is variable.

Fig. 2. *Bacterium;* enlarged four thousand diameters. Prof. Clarke has given especial attention to these bodies, and has shown that they are somewhat more complex than generally supposed. They consist of a dark colored oval nucleus, around which is a transparent space, and around this a gelatinous envelope of extreme delicacy. They are sometimes seen single but generally double; more than two are rarely united together.

Fig. 3. A linear series of globules enlarged five hundred diameters; these have the power of locomotion.

Fig. 4. Excessively faint and colorless bodies of great delicacy, and changing their form under the slightest pressure. They closely resemble the substance described by Virchow as *myeline* which not only forms the medullary sheath of the nerves, but is also found abundantly elsewhere. He says "there scarcely exists a tissue rich in cells in which this substance does not exist in large quantities."*

Fig. 5. This figure, also drawn by Prof. Clarke, represents an organism commonly seen in nearly all of the experiments. It is enlarged thirty-five hundred diameters.

Fig. 6, represents the form of the bodies we have called Monads, and each has a ciliated appendage and is locomotive.

SERIES B.—The flasks in which the experiments described below were made, all had the same capacity, viz. about 70 c. c., and the quantity of solution used in each was from 5 to 8 c. c. After the fluid to be experimented with had been introduced they were sealed at the temperature of the room, placed in a covered vessel containing water, and the whole heated to 212° F., and boiled for various periods.

This method corresponds substantially with that of the Need-

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* Cellular Pathology, translated by Dr. Chance, p. 234. London, 1860.

ham and Spallanzanni. It is in all respects more simple and easier than that in which the apparatus is complicated with a heated tube. This last beyond a question destroys all organisms contained in the air which enter the flask through it, but is without effect on such as may be contained in the solution, or adhere to the inner surface of the glass. These come in contact only with boiling water or steam, and unless destroyed by one or the other of these, would be sufficient to vitiate any experiment, however careful the adjustment and heating of the tube may have been. We therefore believe that the tube is an unnecessary and useless complication of the apparatus.

Exp. VI.—Six flasks prepared as above, and containing from 5 to 8 c. c. of beef juice and water were boiled 30 minutes. The albuminous matter was coagulated, but the fluid portion became perfectly transparent. The contents became turbid and an infusorial film was formed in four of the flasks on the 7th day, and a few days afterwards in the others.

Exp. VII.—Six flasks, each containing about 1 gram of beef and 5 c. c. of water were boiled 30 minutes. An infusorial film was formed on the surface of all of them on or before the 7th day.

Exp. VIII.—A single flask containing a few grains of finely ground bean flour and 5 c. c. of water was boiled 48 minutes. The mixture became filled with Vibrios on the 4th day.

Exp. IX.—Six flasks containing beef juice and water were boiled 30 minutes. A thick infusorial film was formed in all of them on or before the 7th day.

Exp. X.—Six flasks containing each a few milligrams of beef and 5 c. c. of water were boiled 30 minutes. An infusorial film was formed on all on or before the 17th day.

In the preceding experiments of this series, the boiling was continued thirty minutes in four, and forty-eight in the fifth. The following experiments were made for the purpose of ascertaining whether prolonged boiling would be attended with a different result.

Exp. XI.—Five flasks, each containing a few grains of beef, and about 5 c. c. of water were prepared as in the preceding experiments; one was boiled 32 minutes, one 50 minutes, and the other three 1 hour and 20 minutes each.

An infusorial film formed in the first on the 2d day, in the second on the 6th day, in one of those boiled 1 hour and 20 minutes on the 8th, and in the others on the 10th. All were examined and found to contain *Vibrios* and *Bacteriums;* and in addition the first and second contained the "myeloid substance" already described, fig 4. Those which were boiled longest were the latest in developing infusoria; but of those boiled 1 hour and 20 minutes, they appeared two days later than in the other.

Exp. XII.—Twenty-four flasks each containing about 5 c. c.

of beef juice were divided into six series of four each, and boiled for different periods as indicated in the following table; this table also gives the day of the appearance of the infusoria in each of the flasks belonging to a given series.

Series.	Time boiled.	Day of appearance of Infusoria.			
I.	0^{h} 30^{m}	3	4	6	0
II.	0^{h} 45^{m}	4	4	4	4
III.	1^{h} 00	4	4	4	0
IV.	1^{h} 15^{m}	4	4	0	0
V.	1^{h} 30^{m}	4	0	0	0
VI.	2^{h} 00	0	0	0	0

Seven of the flasks produced no infusoria, and the number in which they did appear becomes less the longer the boiling was continued.

Exp. XIII.—Of seventeen flasks containing beef-juice eleven were boiled 45 minutes, and 6 were boiled 2 hours. Infusoria appeared in all of the first series except one, at the end of the second day, and in the remaining one of this series and in all of the second on the 3d day.

It will be seen at a glance that Expts. XII and XIII differ in their results, and that of four flasks in Ex. XII boiled 1 h. and 30 m., three produced no infusoria, while in Ex. XIII the infusoria appeared in all, six of which were boiled two hours. We have several times met with similar differences in successive experiments. Sometimes flasks boiled for a single hour became wholly inert, even when the number of them was quite large. We can only insist that in the above experiments the flasks were properly sealed, and that there was no error as to the time for which the boiling was kept up.

Exp. XIV.—Twenty flasks containing extract of beef were treated as follows:

	No. of flasks in each series.	Time boiled.	Day on which infusoria appeared.				
Series I.	5 flasks.	1^{h}	6	6	6	6	6
" II.	5 "	2^{h}	6	6	6	6	7
" III.	5 "	3^{h}	6	0	0	0	0
" IV.	5 "	4^{h}	0	0	0	0	0

No flask was opened until the sixth day, though there were slight indications of infusoria three days previously; actively moving Vibrios were found in large numbers. The experiment was discontinued on the 10th day, as there was no indication of further change.

Exp. XV.—Thirty-two flasks containing a boiled solution of "extract of beef"* were arranged in six series, and boiled for different times as seen in the following table:

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* This is Borden's concentrated juice of beef, evaporated to a nearly solid substance, is free from tissues, and is entirely soluble.

	No. of flasks in each series.	Time boiled.	Day on which Infusoria appeared.				
Series I.	5	$0^h\ 30^m$	1	1	2	2	2
" II.	5	1 00	2	2	2	2	2
" III.	5	1 30	2	2	2	2	2
" IV.	5	2 20	1	2	2	2	2
" V.	5	3 30	2	2	3	3	?
" VI.	7	4 00	2	2	2	4	4
			4	4			

An infusorial film formed in all the flasks on the days indicated, except in the one marked doubtful in series V, and those of series VI, in which infusoria appeared on the 4th day. None of these last had a film, but, as in the one marked doubtful in series V, had an immense number of minute bodies, which formed a cloud when the flask was shaken, and were not there when the experiment was begun. These bodies were spherical, had an outer wall, and a nucleus which was also a hollow body. They were of different sizes, and seemed to be undergoing multiplication by division. Their real nature must be considered doubtful. The films in the other flasks consisted chiefly of Bacteriums.

The preceding experiments show that if the boiling of the flasks be continued for four hours, as in Exp. XV, the infusoria may appear nevertheless—though in other cases it has happened, as in Exp. XII, that life ceased to be manifested if it was continued only for two hours.

In pushing the experiments still further, we have not found that infusoria appeared in any instance if the boiling was prolonged to five or six hours. Several experiments, in which many flasks were used, were tried, but the result was uniformly the same. Thus a limit to the development of infusoria in boiling water was reached.

SECTION III. *Experiments to show the effect of boiling water on living infusoria.*—In view of the results given above, viz., the development of infusoria in sealed flasks, notwithstanding the precautions taken, the question naturally arises whether the infusoria which appeared were already in the flask and resisted the action of the water at 212° F. If not, then the invasion of the contents of the flasks by them is easily accounted for, since experiment shows that even a very few individuals if present may multiply so rapidly as to fill and make turbid a given solution in a very short time. But on the other hand, if the infusoria perish during the boiling, then any subsequent appearance of them under the circumstances, must be explained in some other way than by the common process of reproduction.

Since large numbers of infusoria can be proved at all times to be floating in the air, we must assume that some are included in every flask, and since certain organisms live in thermal waters at a very high temperature, within a few degrees even of boiling water, the experimenter is called upon to show whether water at the boiling point is or is not destructive of life, before he can venture to offer a theory of the origin of the infusoria in the flasks. It should not be overlooked that a marked difference exists between the conditions of life in the flasks and the thermal springs; in the former, the temperature is suddenly raised from that of the air to the boiling point, while in the latter, the organisms inhabiting them have become adapted to their surroundings through long periods of time. Furthermore it must be remembered that in the two cases, we have to deal with widely different species. It therefore becomes necessary to determine by direct experiment on the species of infusoria found in the flasks what *their* powers of resistance are.

Before proceeding to give the result of the experiments we have made, bearing upon this question, we will notice some of the statements which are constantly urged in support of the opinion that infusoria are capable of resisting water of a very high temperature. Among these are the ones relating to the well known experiments of Doyére and others, in which Tardigrades and Rotifers are asserted to have resisted a heat of 248° F. In these cases the important condition that the organism was in a *dry* and not in a moist state is often overlooked. In truth Doyére himself expressly mentions that in a *moist* condition they perished at 122° F.[*]

In the alleged instances of seeds resisting the action of boiling water, it may be reasonably doubted whether in these the results have not been misunderstood. Spallanzanni clearly proved that if the seeds experimented upon by him were soaked previously to the boiling, they did not germinate.[†] So long as the water does not penetrate to the germ, this is no more influenced by it than if the germ were exposed to dry air heated to the same degree, and this it easily resists. Water penetrates the seeds of many plants and especially of some of the *Leguminosæ* very slowly; in the case of those of *Gleiditchia* and *Laburnum*, we have found several days and even weeks necessary for the complete penetration of cold water, though when the water is hot it penetrates much more readily. If therefore the seeds are dry when immersed, and are boiled for a few minutes only, they may still germinate. If they are moistened beforehand, the action of boiling water has been found uniformly fatal. In one of our experiments twenty-eight seeds of *Gleiditchia* were soaked

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[*] Annales des Sciences Naturelles, t. xviii, 1842, p. 29. The whole subject as regards the resistance of *dried* Rotifers to heat, was investigated in an exhaustive manner by a commission consisting of Balbiani, Berthelot, Brown Sequard, Dareste, Guillermen and Robin. See Comptes Rendus et Memoires de la Societé de Biologie, 1860.

[†] Oposcoli, Milano, 1826, p. 63.

until their coverings became soft and swollen; one half were planted at once, and the others after having been boiled five minutes. None of the boiled ones germinated while all the others did. Similar experiments with beans and with several other kinds of seeds ended in a similar manner.

Pasteur has given the result of his own observations on the effects of high temperature on the spores of some of the different kinds of Cryptogams, and states that they resist when dry 248° to 257° F., but perish at 266°.* He gives no experiments in which the spores were exposed to heated water, or to steam. He excuses himself, however, on the ground of being unable to devise a sufficiently rigorous method of experimentation.† We believe the alleged difficulty can be met, and shall endeavor to show by a series of comparative experiments that definite results may be obtained. From the manner in which Pasteur states his own results, he gives the impression that in view of the fact that the spores resist when *dry* a temperature of 257° F., it is reasonable to suppose that they will resist 212° when *moist.* He does not assert this, but leaves his reader to infer it. We have tried many experiments upon different kinds of moulds and yeast plants and have found, as nearly all observers have, that they perish at 212° F. Every one is familiar with the process of "scalding" in domestic economy, which destroys the kinds of cryptogams ordinarily concerned in fermentation, and on the efficacy of which the preservation of canned meats and other articles depends. As regards moulds the following experiment is decisive. Take any number of cups of paste and sow them all freely with spores; put one half in a covered vessel containing a small quantity of water; boil this for a few minutes, thus exposing the paste and spores to steam, and then set all the cups in similar conditions for light and heat; none of the spores in the series which has been steamed will germinate, while all others will.

Payen is quoted by many writers as asserting that the spores of *Oidium aurantiacum* germinated after having been exposed to 248° F. Pasteur himself expresses the belief that in this case the temperature has been erroneously determined.‡ Payen's own statements are somewhat conflicting. In the one most commonly quoted he says that spores heated in ordinary dough to 120° C. (248° F.), may still germinate, but are so altered at 140° C. (284° F.) that they do not germinate.§ In another and later statement he presents the matter quite differently. "The spores of *Oidium,*" he says, "preserve their vegetative faculty in the soft part of the bread, (*la mie du pain*) the tem-

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* Ann. des Sc. Nat., t. xvi, 1861, p. 81.

† Ibid., p. 85.

‡ Ann. des Sc. Nat., t. xvi, 1861, p. 81.

§ Ann. de Chim. et de Phys., 3me serie, t. xxiv, 1848, p. 254.

perature of which does not exceed 100° C. during the baking;* while in the crust, the temperature which exceeds 200° C. (392° F.) destroyed the vitality of the *Oidium*."† There are here two conditions of the bread recognized; the moist interior which destroys the spores at 212° F., and the dry exterior which does so at 392° F. Mention has also been made of the germination of seeds taken from the raspberry jam, as proof that these had resisted the action of boiling water. But in none of these cases have we seen any evidence adduced to show that they had really been boiled. We have not been able to find a single instance in which seeds or spores or infusoria, excepting only Vibrios, Bacteriums and Monads, thoroughly moistened before the experiment, have resisted the prolonged action of boiling water.‡

The organisms which we have most commonly met with in our experiments in flasks, in fact almost the only ones, when the boiling was prolonged, are *Vibrios*, *Bacteriums* and *Monads*. The first and second are without doubt plants allied to the *Algæ;* the nature of *Monads* is more obscure. They are all among the lowest of living organisms. Leaving out of consideration ciliated infusoria which perish more easily, our inquiry now is, *at what temperature, or after how long an exposure to the action of boiling water are the Vibrios, Bacteriums and Monads killed, and by what signs can we know that they are dead?*—This question is a difficult one to answer.

The usual signs of life manifested by the infusoria found in the flasks are the following: 1st, locomotion in nearly all of the species; 2d, growth and reproduction; 3d, their reaction on the surrounding fluid, producing fermentation or putrefaction. The second and third are so intimately associated that the presence of one is almost a certain indication of the other. If a clear organic solution ferments, or becomes turbid, it may be safely inferred that living infusoria are present; nevertheless the correctness of this inference must be tested with the microscope. The absence of either of the above signs *alone* cannot be considered as a proof of death, and under certain circumstances all *signs* of life may cease, but the infursoria may still be alive. If for example, they are developed in a sealed flask, as soon as the organic matter convertible into infusoria is exhausted their activity ceases, and they remain dormant for months; we have kept them in this way for a year; but if fresh material is supplied to them, they at once resume their activity. Inactivity *in the presence* of organic material suitable for nourishment, and of

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* The baking in this case was for the purpose of destroying the spores in loaves in store, and not for those going into the oven for the first time.

† Precis de Chim. Indust. Paris, 1859, t. ii, p. 150.

‡ The assertion of M. Coste, that encysted infusoria resist the action of boiling water, has been shown to be incorrect by the conclusive experiments of M. Victor Munier.

air at the ordinary temperature, added to the absence of the other signs of life, must be considered as the best indication of death.

1. *Arrest of motion.*—The temperature at which motion ceases was determined as follows: a wide-mouthed bottle containing infusoria was set in a water-bath, and a thermometer suspended with its bulb in the infusorial fluid. The whole was gradually heated, and drops of the fluid were examined from time to time with the microscope, until the motions of the infusoria ceased. The following table gives the result of the examination of fluids taken from several different sources. The movements of the Vibrios lasted longer than those of all other kinds, and the temperature given below is that at which the motions of these were arrested. The motion of all the ciliated infusoria stopped at less than 130° F.

Motion ceased	Experiments.					Average.
	I.	II.	III	IV.	V.	
In infusoria from a macerating tub at	57·5°	57·0°	56·0°	57·0°	56·0°	56·7° C. = 134·06° F.
In infusoria from another tub at	55·0	57·0	58·0	57·0	58·0	56·4 C. = 133·00 F.
In infusoria from beef juice at	55·0	54·0	55·0	54·0		54·5 C. = 130·00 F.
In infusoria from a source not stated at	57·0	55·0	56·0			56·0 C. = 132·90 F.

2. *Arrest of growth and reproduction.*—In the following experiments as a matter of convenience the temperature was always carried to the boiling point, though it by no means follows that this was in all cases necessary. The object was to determine by comparative experiments, whether the growth and reproduction of the infusoria and their reaction upon a given solution is arrested or modified by their having been exposed to boiling water. The solution used in nearly all was beef juice,* obtained by grinding up flesh with water, which was poured off, boiled and filtered; it thus became limpid and well adapted to show the slightest change in transparency which attends the development of infusoria. Equal quantities of the solution were poured into a given number of bottles, and these were divided into three series. Those of the *first* were set aside as criteria; to each of those of the *second* was added a drop of water containing active infusoria; to each of those the *third* was added a drop of the same fluid as in the second series, but after it had been boiled. All were placed together, having a similar exposure to light and heat. By a comparison of the results of the second and third series it will be seen whether the boiling has perceptibly affected the growth and reproduction of the infusoria; by a comparison of the results in either the second or third series with those of the first, the difference will be shown between the effect of adding boiled or unboiled infusoria on the

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* In some of the later experiments, instead of beef juice prepared as above, a solution of Borden's "extract of beef" was used.

one hand, and the simple exposure of the solution to the air without the addition of either, on the other. When an open bottle was used it was in most cases covered with a paper cap to exclude in a measure the dust from the air; this exclusion was of course incomplete, but as all the flasks were equally exposed and large numbers were used, any disturbance would be the same for all, and might therefore be left out of the account. As will be seen further on we have not depended solely on this form of the experiment.

Exp. XVI.—Eighteen bottles of the capacity of 25 c. c. and an inch in diameter throughout and containing equal quantities of boiled and filtered beef juice were divided into three series of six each. All of series I were set aside as criteria; to all of series II were added from a bottle five drops of water containing large numbers of living Vibrios taken from a fluid in which flesh was macerating; to all of series III were added five drops of the same infusorial fluid after it had been boiled five minutes.

On the 2d day all of series II, to which the unboiled infusoria had been added, were turbid from the rapid multiplication of the animalcules, and an infusorial film was formed on the surface of the fluid. All of series I and III were unchanged.

On the 3d day all of I and III had begun to be turbid, and on the 4th were equally so with II.

Exp. XVII.—Thirty-three bottles prepared and arranged as in the preceding experiment were divided into three series of eleven each.

On the 2d day all of series II were turbid and had an infusorial film. The others were unchanged.

On the 3d day eight of series I and seven of series III had become turbid and the rest became so on or before the 6th day.

From the above experiments it is obvious that the boiling of infusoria has a marked effect, since the solutions, to which boiled infusoria were added, did not become invaded by animalcules sooner than those to which none had been added, while those to which unboiled infusoria were added, were in all cases invaded at least one day and in some, two or three days earlier.

In each of the preceding experiments the bottles were all more or less exposed to the air, for the paper covering was only a partial protection. The following modification of them was tried, for the purpose of ascertaining if there would be any difference in the time in which infusoria would appear in portions of the same solution enclosed in two series of flasks, to one of which infusoria had been added, and all of both series sealed at the temperature of the room, and afterwards boiled for the same time. By performing the experiment in this way the influence of dust from the air was eliminated, excepting in so far as it was present in the flasks at the time they were sealed. This would be the same in both series, as it was in the preceding experiments, the only difference being that the quantity would be less, and there would be none which had not been boiled.

Exp. XVIII.—Nineteen flasks of about 75 c. c. capacity, each containing about 15 c. c. of boiled and filtered beef juice were divided into two series, one of nine and the other of ten flasks. All of series I were sealed at the temperature of the room, without any addition to their contents. After a drop of water containing active infusoria had been added to each of series II, these were also sealed at the temperature of the room, and then all of both series boiled 15 minutes.

They were allowed to stand twelve days in a cold room in the winter, when no change having taken place they were removed to a room in which the temperature ranged from 50° to 70° F., day and night. Six days later, on the 18th from the beginning of the experiment, five flasks of each series had become turbid, and on the 20th all had become so. There was no obvious difference between the two series in the time required for the development of the infusoria. A longer time passed before the infusoria appeared than in the experiments with the open bottles, but this is to be attributed in part to the coldness of the room in which they were at first placed. But even in the warm room it was six days before they became turbid.

Exp. XIX.—Seven flasks containing boiled and filtered beef juice were divided into two series—I, consisting of three flasks, had added to the above fluid in each one drop of infusorial fluid, and were sealed and allowed to remain at the temperature of the room. Series II consisted of four flasks prepared as in series I, but after being sealed were boiled 30 minutes.

At the end of 18 hours two of series I had become turbid but none of II. At the 25th hour all of I were turbid and two of II. On the 3d day three of II were turbid and on the 4th all were.

Exp. XX.—A fluid was prepared containing half a gram of extract of beef to 100 c. c. of water. Twenty-one flasks containing this fluid were divided into four series.

Series I, consisting of three flasks which were sealed at the temperature of the room.

Series II, consisting of six flasks, had added to each one drop of dust fluid; this last was made by adding three or four grams of dust from the tops of shelves, to about 200 c. c. of boiled water which had cooled; the mixture was shaken, the heaviest particles of dust allowed to settle, and the rest poured off. At the end of a few days this fluid contained active Vibrios.

Series III, consisted of six flasks containing the same as those of series I, sealed at the temperature of the room, and then boiled 30 minutes.

Series IV, consisting of six flasks, contained the same fluid with the addition of one drop of dust water to each flask; all were boiled 30 minutes.

On the second day one of series I, and all those of II were turbid and had a film—III and IV were unchanged, and perfectly transparent. On the third day infusoria appeared in III and IV, but were confined to the surface, forming a granular looking film, the fluid remaining transparent.

The contents of the flasks were examined with the microscope. I and II contained Vibrois of a large size, some of them extending nearly across the field, and when free moved slowly. III and IV also contained Vibrios, but of a very minute size and moved with great rapidity.

The boiling in the above experiment was followed by a later appearance of infusoria in III and IV than in I and II. The addition of dust water to series II, hastened the development of infusoria. In series IV to which the same dust had been added, but the flask and contents subsequently boiled after being sealed, infusoria appeared one day later.

Conclusions.—The following conclusions appear to the writer to be justified by the observations and experiments recorded in this paper.

1st. In thermal waters plants belonging to the lower kinds of Algæ live in water the temperature of which in some instances rises as high as 208° F.

2d. Solutions of organic matter boiled for twenty-five minutes, and exposed only to air which had passed through iron tubes heated to redness, became the seat of infusorial life. Exps. I–V.

3d. Similar solutions contained in flasks hermetically sealed, and then immersed in boiling water for periods varying from a few minutes to four hours, also became the seat of infusorial life. The infusoria were chiefly Vibrios, Bacteriums and Monads. Exps. VI–XV.

4th. No ciliated infusoria, unless Monads are such, appeared in the experiments referred to in the above conclusions.

5th. No infusoria of any kind appeared if the boiling was prolonged beyond a period of five hours.

6. Infusoria having the faculty of locomotion lost this when exposed in water to a temperature of from 120° to 134° F. Exp. page 172.

7. If Vibrios, Bacteriums and Monads are added to a clear and limpid organic solution, this becomes turbid from their multiplication in from one to two days. If however they have been previously boiled, the solution does not become turbid, until from one to two days later, and in some of the experiments not sooner than does the same solution to which no infusoria have been added.

ART. XVI.—*Remarks on Prof. Geinitz's views respecting the Upper Paleozoic rocks and Fossils of Southeastern Nebraska;* by F. B. MEEK.

THROUGH the politeness of Prof. Geinitz, I have received a copy of his interesting and accurately illustrated work on the Upper Paleozoic rocks and fossils of southeastern Nebraska.* The numerous excellent figures he has here given, of many of our fossils not previously illustrated, will certainly be a great assistance to students, and place them under many obligations to the distinguished author. Being very reluctantly compelled to differ widely from him, however, in regard to many of his identifications and interpretations of these fossils, and feeling it to be a duty to correct errors into which he has fallen, it is but fair to first explain the difficulties with which he had to contend in entering upon this investigation. In the first place, he was, to a great extent, unacquainted with the Coal-measure fossils of this country, and wholly unprepared to understand and appreciate the remarkable mingling here of Coal-measure and Permian types and the frequent alternation of beds containing these two types of fossils, through a considerable thickness of strata. In addition to this, he was necessarily compelled to identify, and form all his conclusions respecting, a number of species described in this country, from descriptions alone, unaccompanied by illustrations; while the collections were submitted to him with erroneous views respecting the relations of the beds from which they were obtained, to the Coal-measures of that region.

It is also proper to further explain, for the information of general readers not familiar with Natural History, that differences of opinion in regard to such matters often arise from the fact that there are two schools of observers amongst paleontologists, as well as amongst investigators in recent zoology. Those of one of these schools give a very wide latitude to genera and species, while those of the other restrict both within more precise limits. That is to say, the first often include in a single genus types which those of the other school distribute into two or more genera, or in some cases, refer even to distinct families. Upon the same principles, those of the first school often regard as mere varieties or unimportant modifications of the same species (if they notice the differences at all) forms that the others consider specifically distinct. As might be expected, these different views respecting the value and importance of distinctive characters sometimes lead to very different conclusions, not

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* Carbonformation und Dyas in Nebraska, von Dr. H. B. Geinitz, M. d. k. L-c. A. d. N. Dresden, 1866.

only in regard to the geographical range of living animals, but also amongst paleontologists, in regard to the geological range, and duration in time, of extinct species and genera; and, as a consequence, respecting the ages and relations of formations. It is proper to add here, however, that the developments of modern zoology are constantly forcing upon our attention the absolute necessity for closer and closer attention to less striking differences in distinguishing genera and species, before we can hope to arrive at reliable conclusions in paleontology.

When it is understood that, out of a list of about ninety species of fossils enumerated by Prof. Geinitz from the beds in Kansas and Nebraska which he regards as belonging in part to the Carboniferous, and in part to the Permian, he identifies about fifty of these species with European, and in part East Indian forms, it will be readily understood by any one familiar with our fossils, that he must be one of those who admit very great diversities of characters as being consistent with specific identity. But before entering upon the discussion of differences of opinion respecting species, it may be well to mention some of the cases where we differ in regard to genera.

First the impropriety of referring to the genus *Turbonilla*, founded upon very small recent shells, ornamented with regular longitudinal costæ, and provided with a *sinistral apex,* shells with only revolving costæ, and a non-reversed apex, such as his *T. Swallowiana*, although not unfrequently done by other paleontologists, must be obvious to those familiar with living Mollusks. That these shells have not a sinistral apex, is well known to the writer, from careful examinations of several allied species from the Coal-measures of Illinois, in which the spire could be traced by the aid of a magnifier, to a minute point, without showing the slightest indications of a reversed apex.* To those unaccustomed to give attention to such characters, this may seem to be an insignificant distinction, but every well informed conchologist is aware that it is found to be coexistent amongst recent shells, with important differences in the anatomy of the animals inhabiting them. For the same reason, as well as on account of their generally much larger size, we may question the propriety of referring *any* of the paleozoic shells often described by paleontologists under the name *Chemnitzia*, and *Loxonema*, to the existing genus *Turbonilla*.

Again we have good reason for believing Prof. Geinitz is far from right in referring the common Coal-measure shell *Euompha-*

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* One of the little shells here alluded to, was described by Dr. Stevens from the Coal-measures of Illinois under the name *Aclis minuta* (this Jour. II, xxv, p. 259); and another by Mr. Worthen and the writer from the same horizon, as *Turritella?? Stevensana* (Geol. Report Ill., ii, p. 382). It is quite improbable that they belong either to the genus *Aclis* or *Turritella*, but they are certainly not Turbonillas.

lus rugosus Hall (not Sowerby), to the articulate genus *Spirorbis.* This shell is probably not a *Euomphalus*, but seems to be more nearly allied to the *Molluscan* genus *Bifrontia.* At any rate, of the thousands of specimens that have been found weathered out of the coal shales of the west, not a single one, so far as known to the writer, has ever been seen attached by the substance of even the first whorl of the shell to any other body; nor are we aware that any scar of attachment has ever been observed on either side of the shell, although they have been frequently examined under a magnifier with the view of determining this very question, in numerous perfect examples, entirely free from the matrix, and showing clearly all the volutions on both sides to the very center.

Nor is Prof. Geinitz's reference of his little *Murchisonia subtæniata*, to that genus, or *family* even admissible. It belongs on the contrary, to the genus *Orthonema* M. & W. (Ill. Report, vol. ii, pl. 31, f. 14), a group of small shells resembling *Murchisonia* in form and revolving markings, but differing in being *entirely without the slit or sinus in the lip* characterizing that whole family of shells. Prof. Geinitz did not see a sinus in the lip of his specimen, nor the corresponding revolving band, but thought a flattened space between two little revolving ridges might be a band, though he acknowledges that this view would indicate a proportionally wide flat band. In order to settle this point, however, an excellent specimen of the species *subtæniata*, was borrowed from Dr. White, the state geologist of Iowa, obtained from exactly the same horizon in the western part of that state, and on examining this by a cross light, under a good magnifier, its lines of growth were seen passing straight across the whorls, without making the slightest flexure such as we see in *Murchisonia* and other genera provided with a sinus in the lip. Several allied species of this genus are known in the Coal-measures of Illinois.

His reference of such shells as the so-called *Modiola squamosa* and *M. acuminata* of Sowerby (as illustrated in Prof. King's Perm. Foss.), to the genus *Aucella*, is also believed to be done on questionable grounds. The genus *Aucella*, it will be remembered, was founded by Count Keyserling, upon a group of Jurassic shells, differing from those mentioned above, not only in wanting their broad cardinal area, marked with linear parallel cartilage furrows, but also in possessing a little abruptly projecting anterior ear, defined in the right valve by a deeply impressed linear furrow extending from the beak to the margin, and terminating there in a sharply cut byssal emargination. Now on examining Prof. King's excellent figures of testiferous examples of the English shells mentioned above, it will be seen that they show no traces whatever, of this little anterior ear, though his figures of internal casts illustrate clearly the broad furrowed cardinal area of *Myalina*, to which genus these shells appear to belong.

It is true Prof. King's figures respecting *internal casts* of these shells, show a little projection between the beaks (as do some of our American species of *Myalina*), that might be mistaken for little ears,* but it is easy to see from perfect specimens showing that outside of the anterior margins of the shell, that these are not external ears, but the casts of a little cavity upon a kind of shelf or septum in the beaks, as stated by Prof. King. Prof. de Koninck mentions this little shelf and its concavity, in describing the genus *Myalina*; and although a more or less variable character, sometimes even in different individuals of the same species, evidences of its existence can generally be seen in the different species of that genus.

Prof. Geinitz has figured in his valuable work "Dyas" under the name *Aucella Hausmanni* (of which he regards the English species *squamosa* and *acuminata* synonyms), German examples of a shell that show, in one of the figures, some indications of a little anterior ear; but if it is really such, and not due to the accidental compression of the valves, as its absence in his other figures indicate, and the shell otherwise agrees with *Aucella*, we may well question its identity with the English forms mentioned above. It is also worthy of note, that Goldfuss's figures of the type of his species *Hausmanni* show no traces whatever of such ears. These shells sometimes have a slight prominence of the anterior margins of the valves, as we see in *Modiola*, but as we know by examining numerous examples of the allied American forms, there is never a defined ear, or sinus, but on the contrary, the margins of the valves fit closely there, and round up to the extremity of the hinge exactly as in *Modiola*.

Another mingling of distinct types under one generic name, is Prof. Geinitz's reference of such shells as the so-called *Monotis speluncaria*, and *Pinna prisca*, to the genus *Avicula*. The first of these types, it will be remembered, is exceedingly unlike the recent shells upon which the genus *Avicula* was founded; being nearly circular, plano-convex shells, with scarcely any perceptible obliquity, and almost destitute of proper alations at either extremity of the hinge. These and other differences led Prof. King to separate the species *speluncaria*, from the genus *Avicula*, and to place it provisionally in the genus *Monotis* Bronn, in which he has, until recently, been generally followed, both in this country and in Europe. On comparing the American

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* A precisely similar cavity exists between the beaks of *Amphicœlia*, Hall, from the Upper Silurian; and internal casts of these look very much like little ears, which the writer at one time supposed them to be; but good specimens of the shell preserving perfectly the anterior margins of the valves, show clearly that there is no external anterior ear whatever.

shells of this type, in 1864, with authentic European examples of the type of Bronn's genus *Monotis* (*M. speluncaria* of the St. Cassian beds), the writer was led by the very nearly equivalve character, and entire *absence of any traces of a byssal emargination* in the latter, to regard these two forms as belonging to distinct genera, and consequently to propose for the *speluncaria* group, the name *Eumicrotis*,* not being at that time, nor until very recently, aware that Beyrich had nearly two years previously proposed to separate this group from *Monotis*, on precisely the same grounds, under the name *Pseudomonotis*.† Prof. Geinitz thinks that if this type should be separated at all from *Avicula*, it should be referred to *Aucella*, which was also sometime back suggested by Prof. McCoy. Although this would be more nearly correct than to refer such shells to *Avicula* or *Monotis*, a strictly systematic classification of all the various groups of the *Aviculidæ*, would forbid such an association.

If those who hold that a natural classification requires the separation of such forms as the genera *Cassianella*, *Pseudomonotis* and *Avicula*, surely they will very decidedly protest against the reference to the latter genus of such shells as the so-called *Pinna prisca* Münster, (=*Avicula pinnæformis* Geinitz).‡ Indeed it seems scarcely possible to conceive of two bivalves within the limits of the same family, more unlike than this and *Avicula*; almost the only character by which it can be distinguished generically from those slender, straight, elongated Carboniferous species of *Pinna*, being the position of its nearly obsolete beaks a little behind the rather pointed anterior extremity, instead of being terminal. Conchologists will readily understand how unlike *Avicula* it must be, when it is mentioned that Prof. Geinitz at one time even referred it to the genus *Solen*.

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* This Jour., II, xxxvii, 216.

† The note of only about one page in which Beyrich proposed the name *Pseudomonotis* for this genus (Zeitschr. der Deutsch. geol. Gesselsch, xiv, p. 10), being unaccompanied with illustrations, or a conspicuous heading to distinguish it from other matter, had escaped the attention of the writer in preparing a classification of the *Aviculidæ*, or the name *Pseudomonotis* would have been adopted. In the same note Prof. Beyrich proposed another genus *Cassianella*, with the *Avicula gryphæata* of Münster as its type. For this, the writer, on the same grounds, proposed the name *Gryphorhynchus*, in 1864. Beyrich's names for both of these genera, however, having priority of date, will have to take precedence. Although neither of these genera would be admitted by those who give such wide limits to groups, it is manifest that such distinctions are attracting the attention of systematic workers everywhere. For instance, Laube adopts *Cassianella* as a good genus in his beautiful Monograph of the St. Cassian fossils recently published. He also there proposes, on apparently good characters, a genus *Hörnessia*, for a group of which the so-called *Gervillia socialis* of authors is the type; though it is probable this will prove to be a synonym of Mr. Gabb's genus *Rhynchopteris*, published in the California Report in 1864, and founded upon a shell presenting similar external characters, and from near the same horizon, in Nevada.

‡ For this type the writer proposed the name *Aviculopinna*, in 1864, (this Jour., vol. xxxvii, cited above.

The propriety of referring the little Permian and Carboniferous shells for which Prof. King proposed the name *Bakevellia*, to the genus *Gervillea*, is, to say the least, very doubtful. Although these types are unquestionably closely related, the uniform smaller size of the species of the former group, the more nearly equal convexity of their valves, usually smaller number of cartilage cavities, and generally less elongated form in proportion to the length of the hinge line, are characters which, when viewed collectively, indicate generic differences. The most important distinction, however, is found in the hinge teeth, which although variable in both groups, differ in that those on the posterior side of *Bakevellia* are elongate, linear and directed parallel to the hinge line, instead of being shorter and oblique; while those in front of the beaks range obliquely forward and downward, instead of forward and upward, as in *Gervillea.* Again *Bakevellia* has the anterior muscular scar proportionally larger, so much so indeed that Prof. King referred the genus to the *Dimyaria*, though it belongs to the *Avicula* group near *Gervillia.*

Again, in including in the genus *Pecten* the Paleozoic shells for which Prof. McCoy proposed the name *Aviculopecten*, Prof. Geinitz ignores important distinctions that have been known for fifteen or sixteen years past, to clearly separate these groups. These are the proportionally larger size of the posterior ear in *Aviculopecten*, instead of the reverse, and its broad *Pterinea*-like cardinal area, or hinge plate, with parallel longitudinal cartilage furrows, and in general without traces of a central cartilage pit under the beaks. Even Woodward, who was the most extremely conservative of all modern conchologists, in regard to generic distinctions, not only separated these shells from the genus *Pecten*, but even placed them doubtfully in the family *Aviculidæ.* No well informed conchologist would at the present time refer to the genus *Pecten*, as properly restricted, any Paleozoic species.*

He is also behind the present state of conchological science in placing in the genus *Arca* forms like the so-called *A. striata* Schlot. (sp.), with the posterior hinge teeth linear, elongated and ranging parallel to the cardinal margin. These belong to the genus *Macrodon* of Morris and Lycett. Even Woodward separates this group from *Arca*, but without sufficient reason includes it as a subgenus under *Cucullæa.* There are no true Arcas in the Paleozoic rocks.

Another unnatural mingling of distinct types is his reference of typical Ledas (properly *Nuculana*,) to the genus *Nucula.*

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* Prof. Agassiz, who has gone over the whole family *Pectenidæ* with great care, and his usual thoroughness, does not, if correctly understood by the writer, refer *any* of the fossil species from older rocks than the Tertiary, to the genus *Pecten*, as properly restricted.

Woodward, Carpenter, Gray, H. & A. Adams, Deshayes, Chenu, in short, all good conchologists admit this as a distinct *genus* from *Nucula;* while Carpenter, H. & A. Adams, Mörch, and other late systematic writers, separate it as the type of a distinct *family* from the *Nuculidæ.*

But the most unaccountable error into which Prof. Geinitz has fallen, is in placing in the genus *Rhynchonella*, *Spirifer hemiplicatus* of Hall, the type of the new genus *Syntrilasma*, Meek & Worthen (Ill. Geol. Report, ii, 321). Being a somewhat peculiar shell, if the cardinal region of the valves was hidden in the matrix, and the surface striæ somewhat obscured, it might be mistaken for a *Rhynchonella;* but the most surprising thing is that he should have referred it to that genus, when the very specimens figured by him show it to have a straight hinge line, and a well defined cardinal area,* divided in the ventral valve by a triangular open fissure, while another figure shows it to have in the dorsal valve, the crura and *cardinal process*, as in *Orthis.* The fact is, this shell does not even belong to the *Rhynchonellidæ*, as its punctate structure and other characters show. The fact that Prof. Geinitz, after referring it to *Rhynchonella*, speaks of it as "this rare and beautiful *Terebratula*," would also seem to indicate that he does not even regard the distinctions between these two genera (well known to be the types of two distinct families), of much consequence.

Again Prof. Geinitz overlooks important distinguishing characters, when he refers (without even a recognition as a subgenus) to the genus *Orthis*, a typical *Streptorhynchus* (properly *Hemipronites*). The distinctions between these types are well defined, so much so that even Mr. Davidson, who is always cautious and conservative in admitting even subgenera, considers it a good subgenus; while most of the highest authorities in various departments of recent zoology view differences of no greater importance as being of full generic value.

Any of the numerous collectors of western Coal-measure fossils will at once recognize the spines figured by Prof. Geinitz (pl. iv, fig. 29), and referred by him to *Actinocrinus*, as those of *Zeacrinus mucrospinus* McChesney. These spines, probably belonging to two or more allied species, are widely distributed in our Coal-measures, from West Virginia and Pennsylvania, to

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* It is scarcely necessary to explain here that when Prof. de Koninck speaks of an area, in describing *Rhynchonella angulata* Linn (to which species Prof. Geinitz refers the shell under consideration), he alludes to a flattened oval space on each side of the shell, converging to the beaks at an angle of about ninety degrees, and not to a true cardinal area, such as that term is applied to in describing Brachiopods generally. If any one, however, has any doubts on this point, these will at once be removed by turning to Mr. Davidson's excellent figures and description of *R. angulata* (Monogr. Brit. Carb. Brach., p. xix), prepared after a careful study of Linnæus's original specimen.

Nebraska, and southward to Texas and New Mexico; while they may be at a glance distinguished from those of any of the forms usually referred to *Actinocrinus*. They belong indeed to different parts of the crinoid, being modified second radial pieces, while those of *A. cornigerous*, and *A. Gouldi*, with which Prof. Geinitz compares them, are modified vault-pieces, that rise obliquely upward out of the vault from above the horizon of the arms. This difference in the position and relations to the other parts, of these spines, imparts an entirely different form to the head or larger extremity, from those of any of the Sub-carboniferous crinoids, that renders it very easy to distinguish them. It is unnecessary to inform any one acquainted with western fossils, that no species of *Actinocrinus*, even giving that genus its widest limits, has yet been found above the horizon of the St. Louis Limestone, of the Sub-carboniferous series, and the only two species found thus far up belong to the *Batocrinus* section.

Having thus pointed out what are believed to be errors in regard to generic references, respecting which students who may use Prof. Geinitz's work ought to be informed, some remarks on the specific relations of these fossils may not be out of place.

First a little planorbicular shell (fig. 6, pl. 1), referred by Prof. Geinitz to *Serpula* (*Spirorbis*) *planorbites* Münster, is certainly, as he suspected, the same figured and described by Prof. Hall from the Coal-measures of Illinois under the name *Euomphalus rugosus*, in the Iowa Report. The reasons, however, for not believing it to belong even to the same primary division of the Animal Kingdom as the genus *Spirorbis*, have already been stated. That it is also clearly distinct specifically from the European *S. planorbites*, even if they could be forced into the same genus, is more positively certain, as I know from a direct comparison with authentic foreign specimens of the latter.* Of the Nebraska shell I have numerous specimens before me, from various localities in that region, as well as from Kansas, western Iowa and from Illinois. On comparing these with German examples of *S. spirorbites*, they are easily distinguished by having the whorls always *very distinctly* quadrangular, and broadly flattened on the outer side, instead of presenting an oval section with a rounded or subangular dorsal side as in the German species. The latter also has its deepest umbilical concavity on the left side (placing the shell with the mouth turned downward and away from the observer), instead of the reverse. Prof. Geinitz had also observed that there is a shallow furrow around the middle of the side of the whorls in the Nebraska fossil, where there ought to be a prominence to make it correspond to the *S. spirorbites*, but thinks this is due to the accidental pressing inward of this prom-

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* All the foreign specimens of Permian fossils alluded to in the paper belong to the Museum of the Smithsonian Institution.

inence. This obscure furrow, however, is a natural character in the *E. rugosus*, though not always equally well defined, and sometimes becoming obsolete. Finally it attains a size of from four to six times that of the *spirorbites*. The latter, as shown by Prof. Geinitz's figures in his "Dyas," as well as by the specimens, varies considerably in some respects, but the American shell is *very* constant and regular in form, and in most of its characters. I differ, if possible, still more decidedly from Prof. Geinitz, in thinking *Spirorbis helix* of King identical with this; and doubt the identity of King's species with the true *S. spirorbites*. If our shell is identical with any European species, it agrees most nearly with the Carboniferous species *Euomphalus carbonarius* Sowerby (=*E. quadratus* McCoy, Carb. Foss. Ireland, pl. 5, fig. 22), which it quite nearly resembles, though even these forms are clearly distinct.

Murchisonia subtæniata Geinitz, Carb. und Dyas, pl. 1, fig. 18. As already stated this is a true *Orthonema*, and will have to take the name *O. subtæniata*.

Bellerophon interlineatus Portlock. Geinitz, ib. This may or may not be identical with Portlock's species. At any rate it occurs in the Coal-measures of Kansas. The *B. carbonarius*, and *B. Montfortianus* N. & P. mentioned by Prof. Geinitz among other fossils from the beds he refers to the Dyas, are well-known Coal-measure species in the West. His *B. Marcouanus* seems to be a good new species.

Macrocheilus Hallianus Geinitz, ib., fig. 7. This probably belongs to the genus *Soleniscus* Meek & Worthen (Illinois Report, ii, pl. 31, fig. 15), as it presents much the appearance of specimens of the type of that genus with the beak and lower part of the outer lip broken away. If the specimen figured has had an *accidental* depression made on the columella above the fold, it may even be the typical species originally described from the Coal-measures of Illinois.

Allorisma elegans King. Geinitz, ib., f. 21. If we may judge from the published figures and descriptions of this species, there can be little room for doubting that the Nebraska shell figured under that name is a distinct species, even after making liberal allowances for variations. If so, it may be called *Allorisma? Geinitzi*, though it seems very doubtful whether it is a true *Allorisma*. It appears to be congeneric with, and allied specifically to, species described by Dr. Shumard from the Coal-measures of Kansas and Missouri, under the names *Leptodomus Topekaensis*, and *L. granosus*. It is probable that all these shells should be referred to the genus *Sedgwickia* of McCoy, as properly restricted to the types for which that name was first proposed (see Paleont. Upp. Missouri, p. 38).

Solenomya biarmica de Vern. Geinitz, ib. The specimen figured is too imperfect for satisfactory identification or to show any reliable characters for distinguishing it from forms in our Coal-measures.

Astarte gibbosa McCoy. Geinitz, ib., fig. 23. This agrees quite nearly with McCoy's figure, but to establish *positive* specific identity would require a comparison of specimens showing the hinge and interior, which *might* even show them to belong to different genera. They are probably both Edmondias, however, and look unlike *Astarte.* Dr. White finds them in the Upper Coal-measures of Iowa.

Astarte Nebrascensis (n. sp.), and *A. Mortonensis* Geinitz, ib., as well as the form he figures *A. Vallisnerianus* King, have more the aspect of *Astarte;* but the latter looks less like Prof. King's figures than the form figured as a new species *A. Nebrascensis.* At any rate, specific identifications, and even generic references of such shells, can be admitted only provisionally, until the hinge and interior is known.

Schizodus obscurus Sowerby, and *S. Rossicus* de Vern. The forms figured under these names on plate I, resemble these European shells quite nearly; but it must be obvious that in a genus like this, in which species vary more or less in outline, and present so few characters for identification, little reliance can be placed upon identifications from external characters only, especially when the specimens were obtained at so widely distant localities. The form referred to *S. obscurus* (figs. 30 and 31), looks more like Prof. King's figures of *S. Schlotheimi* Geinitz, as well as more like natural casts of that species now before me from Germany, than like Sowerby's or King's figures of *S. obscurus,* which shows more elevated, and more ventricose beaks. From a tracing of the type of Prof. Swallow's *Cypricardia? Wheeleri,* described from the Missouri Coal-measures, it appears almost certain that it is the same here figured under the name of *S. obscurus.* Young examples of *S. alpina* (=*Dolabra? alpina* Hall, Iowa Rep., pl. 29, f. 2) from the Lower Coal-measures, in some of its variations, rather nearly resemble the form referred by Prof. Geinitz to *R. Rossicus,* though that is doubtless a distinct species. Dr. White finds both of the shells figured by Prof. Geinitz near the middle of the Upper Coal-measures of Iowa.

Arca striata Schlot. Geinitz, ib., fig. 32. As already explained, the shell figured by Prof. Geinitz under this name is a true *Macrodon.* It is the same species described by Mr. Worthen and the writer (Proceed. Chicago Acad. Sci., i, p. 17) from the Coal-measures at Springfield, Illinois, under the name *M. tenuistriata.* It differs clearly from the European *M. striata,* however, of which I have good examples at hand for comparison, in having its radiating lines very much smaller, or reduced to minute obsolescent striæ on the middle and anterior half of the valves. The specimen figured by Prof. Geinitz only retains the shell at the posterior end, where the striæ are stronger, and agree more nearly with those of the European form. Through the politeness of Dr. White, I have had an opportunity to compare good gutta-percha casts of the hinge of this shell, from the same horizon in western Iowa as the Nebraska City beds, and they agree well with the Illinois shell. I am aware that *M. striata* varies in the size of its striæ, but it never has them reduced to very minute or obsolete lines on the anterior part of the valves, like the American species, which is quite constant in this character. I agree with Prof. King and others in believing some of the European forms Prof. Geinitz thinks identical with the species *striata*, are specifically distinct.

Nucula Kazanensis de Vern. Geinitz, ib., f. 33–34. The figures of the species *Kazanensis*, originally published in the Geology of Russia, being merely from imperfect moulds left in the matrix, do not afford a reliable means for comparison, though they look like the Nebraska shell. Whatever may be its relations, however, to the *Kazanensis*, it will be readily recognized by those familiar with the western Coal-measure fossils, as the form described by Dr. Stevens from the Coal-measures of Illinois under the name *Leda bellistriata*. Of course it is not a *Nucula*.

Nucula Beyrichi Schloth. Geinitz, ib., 36 and 37. This has the form of a true *Nucula*, and agrees pretty well in form with Prof. Geinitz's figures of German examples of that species given in Prof. Geinitz's "Dyas," but less nearly with specimens sent from Germany under that name. They are probably the same described by McChesney from the Coal-measures under the name *N. parva*.

Clidophorus Pallasi M. V. & K.* Geinitz, ib., pl. II, fig. 3, (fig. 4 appears to represent some other shell.) This figure was evidently made from the internal cast of a shell very near, if not identical with, *Pleurophorus occidentalis* Meek & Hayden, to which *genus* at least it certainly belongs. It may, or may not be, identical with some of the German shells referred to the Russian species *Pallasi*; but if we are to be guided in regard to the true characters of the type of that species by the figures and description published by its founders in the Geology of Russia, the Nebraska shell, which is shown to have the posterior hinge-teeth at least of *Pleurophorus*, must be a very different type, since the Russian species is both figured and described as being "*completely edentulous*." The Russian species is therefore not a *Pleurophorus* (= *Clidophorus*) at all, but is more probably, as suggested

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* If *Pleurophorus* and *Clidophorus* are synonyms, or only sections of the same genus, it is *Pleurophorus* and not *Clidophorus*, as Prof. Geinitz seems to think, that must take precedence, as King proposed the former genus, naming the so-called *Arca costata*, as its type, in 1844, while *Clidophorus* was not published by Prof. Hall until 1847.

by Prof. King, a *Cardiomorpha*. It also differs from the Nebraska shell in having the internal ridge bounding the anterior muscular scar (as shown in the figures and mentioned in the description) ranging obliquely backward and downward at an angle of 45° to the axis of the valves, instead of nearly at right angles to the same, as shown in the figure of the Nebraska species.

I have now before me an internal cast, and a specimen showing the exterior, of what are strongly suspected to be two very distinct types, that came from Germany with the name *Clidophorus Pallasi* attached. The one showing the exterior agrees quite well with some of Prof. King's figures of his *Cardiomorpha modioliformis*, which Prof. Geinitz cites as a synonym of the Russian species *Pallasi;* but the other specimen, that is, the internal cast, shows that *it*, at least, is a true *Pleurophorus*, as it has a hinge with teeth like the Nebraska shell; while one of Prof. King's figures of a cast and his description show that his *modioliformis* is edentulous, like the species *Pallasi*.

From these facts, it seems highly probable that two types are, at any rate sometimes, confounded in Germany, under the name *C. Pallasi*;* that is, one edentulous, agreeing perhaps specifically with Prof. King's *modioliformis*, and another with a toothed hinge, or in other words a true *Pleurophorus*. If the Nebraska shell belongs to any European species, it is far more probable that it is identical with *Pleurophorus costatus*, with casts of which, now before me from Europe, Prof. Geinitz's figure closely agrees.

Clidophorus (*Pleurophorus*) *occidentalis* M. & H. Geinitz, ib., tab. ii, fig. 6. The shell figured under this name is certainly not the *P. occidentalis* Meek & Hayden. In that species, the beaks are, as described, narrow and projecting beyond the termination of the hinge, being in fact nearly or quite terminal, while its dorsal outline is straight or even a little concave from the beaks posteriorly. The form figured by Prof. Geinitz is, so far as known to the writer, new, and may be called *Pleurophorus subellipticus*.

Cl. (*Pleurophorus*) *simplus* von Keyserling. Geinitz, ib., fig. 5. Prof. Geinitz did not have specimens of this shell from Nebraska, but gives a figure copied from Dana's Geology of a specimen from the Permian rocks of Kansas. It is the *P. subcuneatus* M. & H., and occurs both in the Permian and Permo-carboniferous beds. It varies considerably in form, and some of the varieties like that figured in Prof. Dana's Geology resemble *P. simplus*, though among all of the hundreds of examples I have seen, not one is proportionally so slender and elongated as the figure of the Russian shell. Nor have any of them the posterior hinge-teeth prolonged nearly so far backward.

Clidophorus solenoides Geinitz, ib., fig. 7. This is a good species of genus ?

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* Prof. King says Prof. Geinitz formerly confounded *Pleurophorus costatus* with the edentulous so-called *Mytilus Pallasi*.

Aucella Hausmanni Goldf. Geinitz, ib., fig. 8. This is doubtless a *Myalina* resembling the *M. squamosa* of England, but it is less nearly like *M. Hausmanni*, as figured by Goldfuss, and quite unlike Prof. Geinitz's figures of German specimens referred to that species. It is doubtless the same as *Myalina Swallovi* of McChesney, from the Missouri Coal-measures. I have also seen a similar form from beds in Nova Scotia, referred by good authorities to the Sub-carboniferous.

Mytilus concavus? Swallow. Geinitz, ib., fig. 9. This is not the form described by Prof. Swallow, which has angular instead of rounded umbonal slopes. It may be a *Myalina* but it is *certainly* not a true *Mytilus.*

Myalina perattenuata M. & H. Geinitz, ib., fig. 10–11. Correctly identified, but it is specifically distinct from *M. permiana* Swallow (cited by Geinitz as synonym), which has less attenuated beaks.

Myalina subquadrata Shumard. Geinitz, ib., figs. 25 and 26. Correctly identified. It is common in the upper Coal-measures of this region, and has been found by Dr. White in the same horizon in Iowa.

Avicula speluncaria Schlot. Geinitz, ib., fig. 12. As already stated, this belongs to Beyrich's genus *Pseudomonotis.* The specimen figured by Prof. Geinitz is not from Nebraska, but was sent to him by Prof. Dana from the Permian beds of Kansas, and is the same shell described by Dr. Hayden and the writer under the name *Monotis Hawni.** It nearly resembles the European species *speluncaria*, and may *possibly* be identical, but good European specimens of that species now before me can be distinguished from the American form. At any rate we have a specimen from a bed of nearly black limestone, far down in the Coal-measures at Leavenworth, Kansas, agreeing even more nearly with *P. speluncaria* than *P. Hawni* does. Similar forms occur at different horizons in the Coal-measures and Permo-carboniferous beds in Kansas, and have been found in the Upper Coal-measures of Iowa, by Dr. White.

Avicula pinnæformis Geinitz, ib., fig. 13. From specimens of this shell shown to me by Dr. White from the same horizon in Iowa, I am sure it is specifically distinct from the so-called *A. pinnæformis*, and there can be little doubt that it even belongs to the distinct genus *Pinna.*

Gervillia parva M. & H. Geinitz, ib., 14. This differs from the *Bakevellia parva* M. & H. in having a broad shallow depression extending to the anterior basal margin from the umbonal region, farther back than that defining the anterior ear from the

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* The species *Hawni*, will have to take the name *Pseudomonotis Hawni*, and the Illinois shell, supposed to be a variety of the same but probably distinct, may be called *P. sinuata.* (See Ill. Geol. Report, ii, pl. 27, fig. 12–13.)

swell of the umbo in *B. parva.* It is an interesting fact, however, that there is a little shell, of which we have specimens for comparison, in the Nova Scotia beds, referred by the highest authorities to the Sub-carboniferous, agreeing with it in this character as well as apparently exactly in all other respects.

Gervillia longa Geinitz, ib., ii, fig. 15. A good species, but its position in the genus *Gervillia* is very doubtful. It occurs in Iowa, in a bed referred by Dr. White to the upper part of the Lower Coal-measures, with other fossils of that horizon.

G. (*Avicula*) *sulcata* Geinitz, ib., fig. 16. Also a good species.

Pecten neglectus Geinitz, ib., fig. 17. Appears to be a good species, but should be called *Aviculopecten neglectus.*

Pecten Missouriensis? Shumard. Geinitz, ib., fig. 18. This is certainly not the *Aviculopecten Missouriensis* of Shumard, which is not known from any horizon above the St. Louis limestone of the Sub-carboniferous series. It is the shell called *P. occidentalis* by Dr. Shumard, and afterward named *P. Cleavelandicus* by Prof. Swallow. It is one of the most widely distributed of our Coal-measure shells throughout the West, and ranges up through the Permo-carboniferous beds into the Permian of Kansas. No form nearly allied to it has ever been found in the western Sub-carboniferous rocks, but specimens now before me from rocks in Nova Scotia, so referred by the most reliable authorities, seem to be undistinguishable from it.

Pecten Hawni Geinitz, ib., fig. 19. This seems to be quite similar to *Pecten Broadheadii* of Swallow, described from the Missouri Coal-measures. If distinct from that species it should be called *Aviculopecten Hawni,* unless it may possess internal characters showing it to be the type of an undescribed genus. Dr. White finds it in the upper beds of the Lower Coal-measures of central Iowa.

Rhynchonella angulata Linn. Geinitz, ib., tab. iii, fig. 1–4. As it has already been shown that the shell figured under this name is not a *Rhynchonella* at all, little need be said in regard to its *specific* relations to the European true *Rhynchonella angulata.* I hope, however, that I shall be excused for adding here, that the practice of positively identifying species from widely distant parts of the earth upon such merely superficial points of general resemblance, and thus complicating and vitiating all conclusions respecting the geographical and geological range of species, cannot be too carefully avoided.

Camarophoria globulina Phillips. Geinitz, ib., fig. 5. Of this shell I have numerous examples from the same position, as well as from other horizons of the Upper Coal-measures of Missouri, Kansas, Nebraska and Iowa. It has generally been referred to *Rhynchonella Uta* of Marcou, who has himself identified it with that species. On comparison with authentic European examples of *Camarophoria globulina* of Phillips, it is found to be very similar in external characters, but there is an insurmountable difficulty in the way of referring it to that species,—that is, because sections across the beaks, as well as internal casts, show it to be *a true Rhynchonella?*

Retzia Mormonii Marcou (sp.). Geinitz., ib., fig. 6. This is the species described by Dr. Shumard from the Coal-measures as *R. punctulifera*, and his name probably has priority. It is a very common Coal-measure and Permo-carboniferous form in the west. Prof. Marcou mentions finding it at Nebraska City associated in bed C of his section with the other species referred by him and Prof. Geinitz to the Dyas;* though Prof. Geinitz does not mention it among the Dyas fossils at all, but refers it to the Carboniferous, giving Plattsmouth as the locality. Prof. Geinitz makes the California *R. compressa* a synonym of this, but the reasons for doing so are not very apparent, the two shells being quite different; he might with more propriety make the *R. Mormonii* a synonym of the European species *R. radialis* Phillips.

Athyris subtilita Hall, a form generally referred to *A. planosulcata* Phillips, *Spirifer planoconvexus* Shumard, *S. cameratus* Morton, and *Streptorhynchus crenistria* (properly *Hemipronites crenistria*), the so-called *Orthisina Missouriana*, figured or mentioned by Prof. Geinitz from beds he refers in part to the Dyas, and in part to the Carboniferous, all occur together, with the *Rhynchonella Uta*, *Retzia Mormonii*, and all of the *Producti* mentioned by him, as well as *Fusulina cylindrica*, in the same or alternating beds of the Coal-measures and Permo-carboniferous beds in Kansas, while *Athyris subtilita* ranges up into the highest beds containing Permian types.

Prof. Geinitz makes Mr. Davidson's East Indian *Spirifer Moosakhaliensis* a synonym of *S. cameratus* Morton. In this, however, he is certainly mistaken. Out of all the thousands of specimens of *S. cameratus* found in our western Coal-measure and Permo-carboniferous rocks, not one shows the distinct regular concentric lamellæ seen on that species, while there are other differences not to be overlooked.

Spirifer laminosus McCoy. Geinitz, ib., fig. 19. This is *positively* not *S. laminosus* McCoy, but merely a variety of *Spiriferina Kentucensis*, of Shumard. It agrees with *S. laminosus* in no specific character excepting the possession of regular laminæ of growth, *S. laminosus* having a high flat area like a *Cyrtia* (to which group Prof. McCoy referred it), and a broad rounded mesial fold and sinus without longitudinal plications. One of McCoy's figures of a distorted specimen seems to show a plication in the sinus, but it is only necessary to consult Mr. Davidson's excel-

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* See Bull. Soc. Geol. France, t. xxi, p. 137, 1864.

lent figures and description of this species in his Monograph of the British Carboniferous Brachiopoda, or Prof. McCoy's description in his British Paleozoic fossils, to be convinced that the two shells are totally distinct. Indeed they probably belong to distinct subgenera or genera, as the *S. Kentuckensis* seems to be punctate like *Spiriferina.*

He is probably right in making Prof. Swallow's so-called *Orthisina Missouriana* a synonym of *Plicatula striato-costata* Cox, which I had done some years since. Dr. White and Mr. St.John, however, have ascertained that it posesses some very extraordinary intermal characters, showing it to be typical of a new genus. Although this shell closely resembles Mr. Davidson's East Indian *Streptorhynchus pectinifera*, with which Prof. Geinitz thinks it identical, they must be specifically distinct, if Mr. Davidson's figure represents the striæ correctly as running parallel to the plications to the front margin, instead of converging toward the top of the plications near the front.

If Prof. Geinitz is correct in identifying the shell he refers, without figure or description, to *Productus horrescens* with *P. Rogersii*, it is the same described by Dr. Owen under the name *P. Nebrascensis.* Dr. Owen's figure gives a very incorrect idea of this shell, and would never be recognized as even representing an allied form, but the locality from which he obtained his specimens and his comparisons with *P. Humboldtii* d'Orbigny, led to the belief that his type was the same as the *Rogersii.* In order to settle this question I borrowed Dr. Owen's typical specimens, labelled by himself, from his brother, Prof. Richard Owen, and found it to be the common Coal-measure shell generally known in the west as *P. Rogersii.* Out of thousands of specimens of this species, showing the hinge and interior of both valves, examined under all conditions and of all ages, not one has ever been seen showing any traces whatever of the cardinal area and hinge-teeth of *Strophalosia.* In short it is a true *Productus* closely allied to *P. scabriculus.*

Productus cora, *P. semireticulatus*, *P. costatus*, *P. punctatus*, &c., mentioned but not figured by Prof. Geinitz, are doubtless the same Coal-measure forms usually so referred in the west, and ranging in part up into the Permo-carboniferous. That he figures under the name *P. Flemingii*, is the same Coal-measure and Permo-carboniferous shell described by Dr. Norwood as *P. Prattenianus* (as indicated by Prof. Geinitz), which is also closely allied to *P. æquicostatus* Shumard, though it is certainly not the *P. Calhounianus* Swallow, nor *P. Flemingii*, as Prof. G. thinks. The other shell he figures under the name *P. Koninckianus* de Verneuil, looks exceedingly unlike the figures of the type of that species, being more probably only a larger individual of the same he figures as *P. Flemingii.*

Productus Cancrini de Vern. Geinitz, ib., iv, fig. 6. Whatever relations the shell here figured bears to German specimens identified with *P. Cancrini,* it certainly differs from the original Russian type of that species, both in its proportions and in the prominence of its beak. At any rate I know it to range far down in the Coal-measure rocks of Kansas, below the horizon of the beds referred by Marcou and Prof. Geinitz to the Mountain limestone.

Productus Orbignianus de Koninck. Geinitz, ib., figs. 8 to 11. Prof. Geinitz seems to be right in regarding this form as the same as *P. splendens* and *P. Wabashensis* N. & P. But Mr. Davidson, however, who ought to know, refers both of these, from specimens sent him from the typical localities, to the Carboniferous species *P. longispinus* Sowerby. The shell figured by Prof. Geinitz is widely distributed and very abundant in our Coal-measures, and in Kansas ranges up into the Permo-carboniferous.

Productus horridus Sow. Geinitz, ib., fig. 7. There is no room whatever, to doubt but this is a young individual of the last mentioned species. That shell varies much in the distinctness of its costæ, which are sometimes almost entirely obsolete on even adult shells, and in young examples like this they are often not indicated at all, as may be seen by examining the the umbo of mature specimens. If *P. horridus* was known to occur in these rocks, it might be thought *possible* that this might be its young, but under existing circumstances, (that species being unknown in America), it would certainly require a considerable stretch of imagination, to see in this little shell a species which at maturity attains nearly one hundred times its size.*

Chonetes mucronata M. & W. Geinitz, ib., tab. iv, figs. 12, 14. This is correctly identified; and his *C. glabra* (ib., figs. 15 to 18) seems to be a good species. Both of these species, however, range far below this horizon in Kansas and Nebraska, even below the horizon of the beds referred by Professors Marcou and Geinitz to the Subcarboniferous.

Cyathocrinus ramosus Schlot. Geinitz, ib., fig. 19. Is from a European specimen, and given for comparison with the next, to which, however, it has no near relations. *C. ramosus* has not yet been found in any of our rocks.

Cyathocrinus inflexus Geinitz, ib., fig. 20. This species was long since described by Dr. Shumard from the Coal-measures of Missouri, under the name *Poteriocrinus hemisphericus* (Acad. Sci. St. Louis, i, p. 221). It is widely distributed in the western Coal-measures. Several specimens of it are in the Illinois collection from different localities in that state; and it is now known

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* Since this was written, I have had an opportunity to examine extensive collections obtained by the Nebraska geological survey in charge of Dr. Hayden, at Nebraska City and all the surrounding country, and can assert *positively* that the little shell here figured is the young of that referred by Prof. Geinitz to *P. Orbignianus.*

to occur at Omaha, in the beds referred by Prof. Marcou to the Mountain limestone. The separate crinoid plate (fig. 27) given by Prof. Geinitz on the same plate, is a first radial piece of the same species as the above, or of *Erisocrinus*, it being impossible to distinguish this part of these *Crinoids* when found detached. The fig. 28 of same plate, evidently represents the subradial piece of the *C. hemisphericus* from the anal side, being truncated above for the reception of the first anal piece and strongly incurved below. The columns figured on this plate as *Actinocrinus?* probably belong to the same crinoid, or to *Zeacrinus mucrospinus* McChesney, the spines of which are figured there erroneously as those of an *Actinocrinus*. As already stated, no *Actinocrinus* has yet been found in this country above the St. Louis Limestone.

Eocidaris Hallianus Geinitz, ib., tab. v, fig. 1, is probably a good species, and correctly referred. The corals figured on the same plate and referred to *Cyathaxonia*, are very like Coal-measure species of the West. One of them may be the same described by McChesney from the Coal-measures of Illinois under the name *C. prolifera*. The *Fusulina* figured on the same plate as *F. cylindrica* and *F. depressa*, range through our whole Coal-measures, of Iowa, Missouri, Kansas and Nebraska, and far up into the Permo-carboniferous of Kansas.*

As the so-called *Fenestella elegantissima* Eich., *F. plebeja* McCoy, *F. virgosa* Eich., and *Polypora papillata* McCoy, figured on plate v, are all identified from fragments showing but the nonporiferous side, such identifications are of course not to be relied upon in determining the age of rocks.

Polypora marginata McCoy. Geinitz, ib., fig. 11. The poriferous surface of this looks very unlike McCoy's species.

Polypora biarmica von Keyserling. Geinitz, ib., fig. 13. If the figures of this, and the form described by Count Keyserling are even nearly correct, they are clearly distinct.

Synocladia virgulacea Phillips. Geinitz, ib., 14. Prof. Geinitz has correctly identified this with the type for which Prof. Swallow proposed the name *S. biserialis*. It differs, however, clearly from the *S. virgulacea*, in having a row of little short spines (not mere granules) along the middle of each longitudinal branch, between the two rows of pores, and *particularly* in having *but two* rows of pores, instead of from three to five. Prof. Geinitz's figure shows the nonporiferous side, but his artist (who deserves great credit for his accuracy) has well represented the impressions of the row of little spines along the middle of the poriferous side, in impressions left in the matrix.

(To be continued.)

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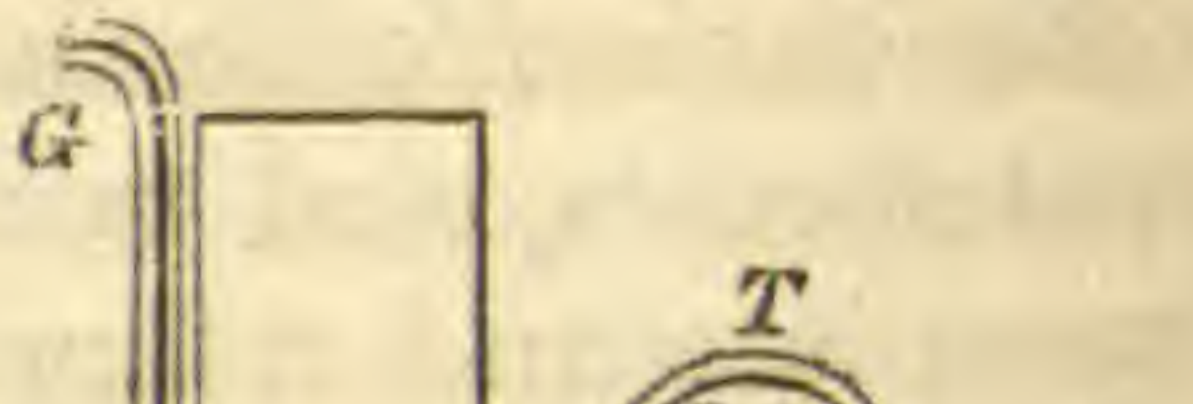
* Since this was written, I have this fossil in abundance, and many of our other common Coal-measure forms, from Nebraska City, obtained *above* the horizon of the very beds from which the so-called Dyassic fossils were obtained.

ART. XVII.—*Description of an apparatus for collecting and washing precipitates in test tubes;* by M. McDONALD, Prof. Chem. Va. Military Institute.

THE apparatus is shown in the figure in side elevation. A is a bracket of hard wood or other suitable material, and serves as a support to the test tubes. It is firmly attached to the upright D which carries the inverted syphon tube G, G′, G″. It has a shoulder at I which abuts against the fixed support C and prevents oscillation.



Upon the bracket A rests the disk E of porous biscuit ware, and upon this, several thicknesses of filtering paper. The test tube T is adjusted as shown in the figure, and held firmly in place by a clamp (which is not shown). There is an orifice through the center of A and E through which passes the shorter branch of the inverted syphon tube G, G′, G″. This is drawn to a capillary bore at G″, and serves to introduce distilled water into the interior of the test tube for the purpose of washing the precipitate. The apparatus is supported upon the stand BC, and has a motion of rotation around the axis P.

The disks of filtering paper have a diameter slightly less than the diameter of the disk E; their centers are perforated with holes a little less in diameter than the syphon tube at the point F.

To use the instrument, several thicknesses of filtering paper are slipped over G″ and pressed evenly down upon E. The apparatus is then inverted in its frame, the test tube containing the precipitate adjusted and secured in position by the clamps and then restored to the position shown in the figure.

The syphon tube is then connected with the delivery tube of a wash bottle and a jet of distilled water thrown into the interior of the test tube.

Usually this jet may be projected against the bottom of the tube with sufficient force to wash all the precipitate down upon the filter. The test tube should fit very closely upon the support, or the pressure will force liquid and precipitate through together.

Modifications of the apparatus for special purposes will readily suggest themselves, and any one of ordinary ingenuity may construct one for himself.

ART. XVIII.—*On certain Lecture Experiments, and on a new form of Eudiometer;* by JOSIAH P. COOKE, Jr.

THE laws of combination by volume fill such an important place in our modern chemical philosophy that simple methods of illustrating these fundamental principles in the lecture room are eagerly sought by every teacher of the science. The many new and interesting experiments devised for this purpose by Prof. Hofmann, first described in the Journal of the Chemical Society of London (Ser. II, vol. iii, page 156), and subsequently made still more widely known through his admirable "Introduction to Modern Chemistry," leave little to be desired so far as regards accuracy of results or elegance of illustration. But these experiments require for the most part a delicacy of manipulation, which is incompatible with the hurry of the lecture room, and a skill in glass-blowing which can rarely be attained or commanded by our American teachers. Hence while seeking the same end as Professor Hofmann, but with less ample appliances, the author has devised for his own lecture-room methods of illustrating the same principles, which require less delicate apparatus and less careful attention, although as analytical methods they may not always be as accurate as those of this eminent German chemist. Following also the recommendation of Prof. Hofmann in the article just referred to, the author publishes his methods with the hope that they may serve to bring the illustrations of these fundamental laws of chemistry within the reach of the great body of teachers in this country.

Many of the methods described in this paper are alone rendered possible by the application of vulcanized rubber stoppers in the construction of the required apparatus. Hitherto these have not been made of good quality in this country, and those imported from Europe were very costly, and could only be obtained of a few invariable sizes. At the suggestion of the author, the "Boston Belting Co." now manufacture an excellent article, which they call "stopper cord," consisting of conical rolls of very elastic rubber, about 4 feet in length and varying in diameter from one-half an inch at one end, to an inch and a half at the other.* From these rolls, stoppers of any required size between the limits named may be cut with an ordinary knife and bored with a common brass cork-borer. It is only necessary to moisten the tools with water in order to prevent the adhesion of the rubber. Stoppers of this material are absolutely air-tight

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* After a good deal of experience, rolls of the sizes named above have been found to be the most universally applicable, but they can be made to order of any desired dimension and at a cost not exceeding one dollar a pound. See fig. 5, where one of these rolls is shown in the fore-ground of the wood cut.

even against a full atmospheric pressure, provided that the surface of adhesion to the glass neck is at least half an inch in length.

Another material of prime importance in these experiments is sodium amalgam, which is most conveniently used when containing so large an amount of sodium as to form a hard solid. It is best prepared by gently heating a few ounces of metallic mercury in a shallow iron dish and then cautiously adding one-twentieth of its weight of sodium. The first half of the sodium should be added in very small portions at a time as the action at the beginning is exceedingly violent, but soon moderates, and at last the melted amalgam must be stirred with an iron spatula in order to incorporate thoroughly the materials. As soon as cold the solid amalgam readily separates from the dish, and should then at once be broken up into small fragments and preserved in a well stoppered bottle.

The four great typical compounds of modern chemistry are HCl, H_2O, H_3N and H_4C. Excepting the last, for which we have no new methods, we will now describe our methods of illustrating the composition of each of these in turn.

Hydrochloric acid.—The points to be illustrated in the case of this gas are all indicated by the equation $\boxed{\mathrm{H}} + \boxed{\mathrm{Cl}} = \boxed{\overbrace{\underbrace{\mathrm{H\,Cl}}}}$ or by the molecular expression

$$\boxed{\overbrace{\underbrace{\mathrm{H\,H}}}} + \boxed{\overbrace{\underbrace{\mathrm{Cl\,Cl}}}} = \boxed{\overbrace{\underbrace{\mathrm{H\,Cl}}}}\,\boxed{\overbrace{\underbrace{\mathrm{H\,Cl}}}}$$

The first fact that HCl consists of hydrogen and chlorine gases we prove by the electrolysis of strong liquid hydrochloric acid, having previously shown in the course of the lecture how HCl is obtained from common salt, and that the liquid acid is merely a solution of the gas in water. The decomposing cell, which we use in this experiment, is represented in outline by fig. 1, which is drawn to a scale of $\frac{1}{5}$, so that both its construction and dimensions require no detailed description. The two small open glass cylinders are fitted by grinding with emery to the two tubulatures of the cell, and when the instrument is not in use are closed above with ground glass stoppers. When mounted for use the cell is filled with strong hydrochloric acid to within an inch of the upper mouths of the cylinders, and the glass stoppers are replaced by rubber stoppers, through which pass the gas delivery tubes and the conducting wires connecting with the electrodes, which are two strips of platinum foil four inches long by

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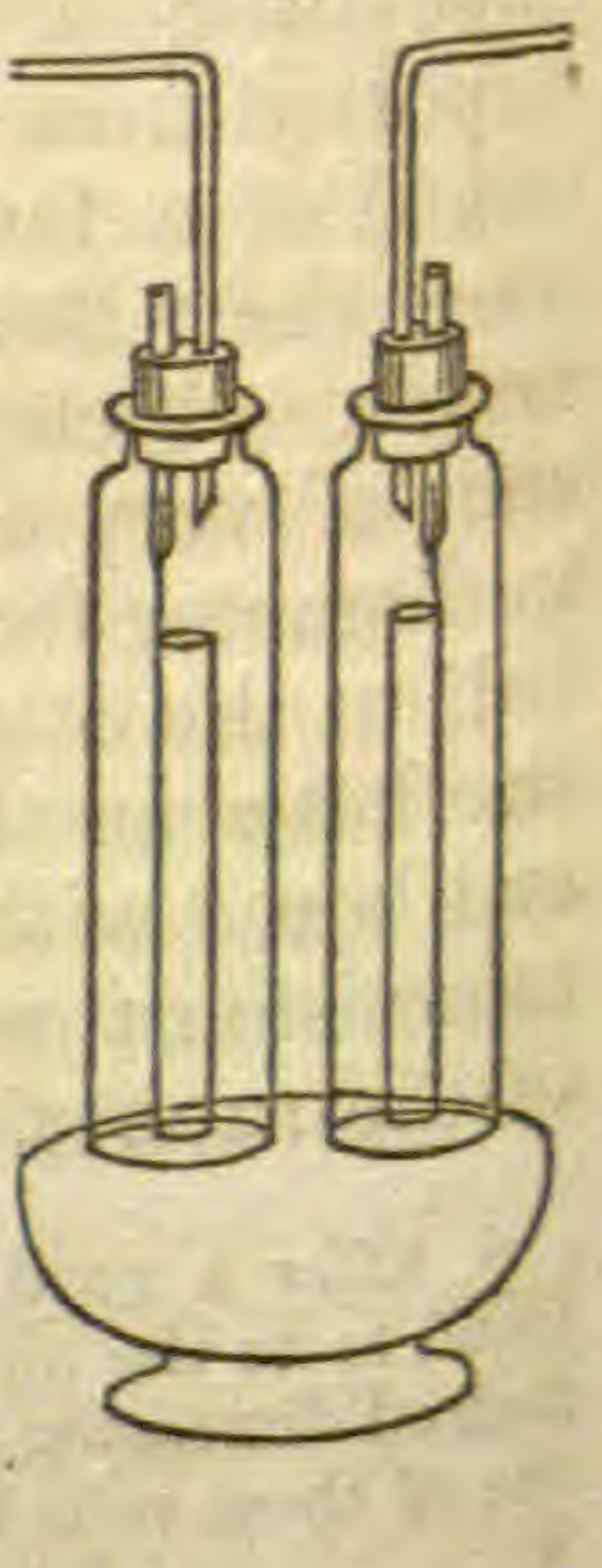

one inch wide. The platinum conducting wires are welded* to the strips of foil and secured in the rubber stoppers as represented in detail by fig. 2. Into the lower end of a short piece of glass tube, which passes tightly through the rubber, the platinum wire connecting with the foil is secured by melting the glass around it, while the upper end is left open to receive the copper conducting wires from the battery, and the connection is made perfect by placing a few drops of mercury in the tube. This simple form of connecting-cup is easily made and very convenient.

2.

As the conducting power of hydrochloric acid is very good, three Bunsen cells of the ordinary size have ample intensity and give a rapid evolution of gas. The hydrogen gas is conducted into a tall but narrow glass jar mounted in the usual way over a small pneumatic trough, while the chlorine is collected by displacement in a precisely similar jar mounted as represented in fig. 3. The mouth of this jar is closed by a ground glass plate, which is tubulated, as is shown in detail by fig. 4. This tubulature again is closed by a rubber stopper, through which pass first, the delivery tube, which reaches the bottom of the jar, and secondly an overflow tube which merely passes through the stopper, and which in the experiment should be connected by a flexible hose with a ventilator. When a larger amount of chlorine is desired the first jar may be connected with a second, and that with a third, etc., all mounted in the same way, and the exit tube from the last jar leading to a ventilator as before. When the jars are full the tubulated stoppers with their connections are removed and a plain glass cover substituted. This simple form of apparatus will be found very useful in all experiments on gases heavier than the air.

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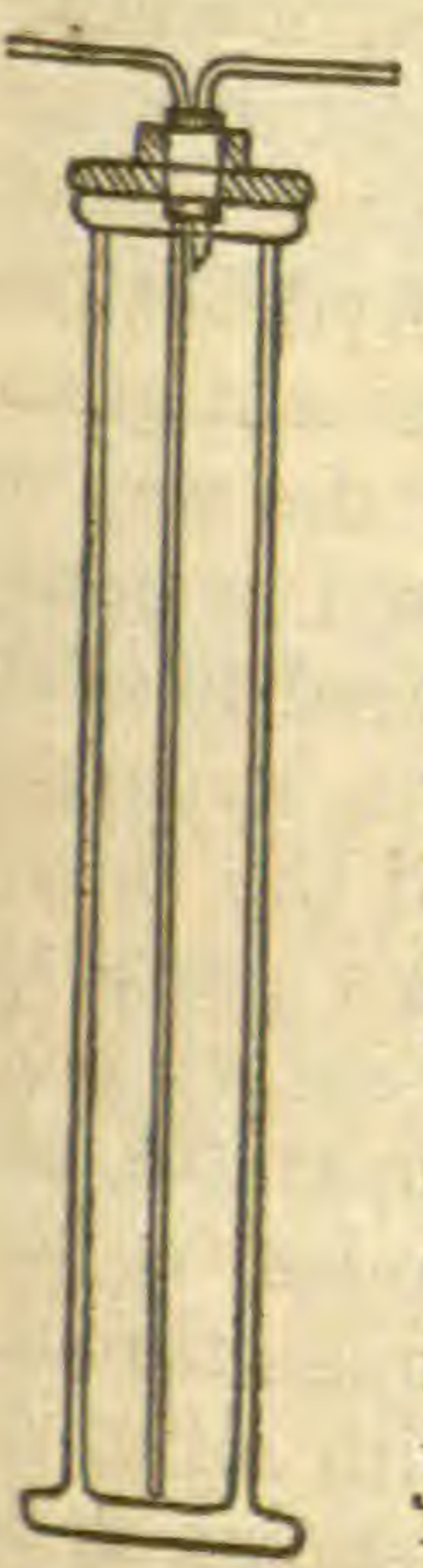

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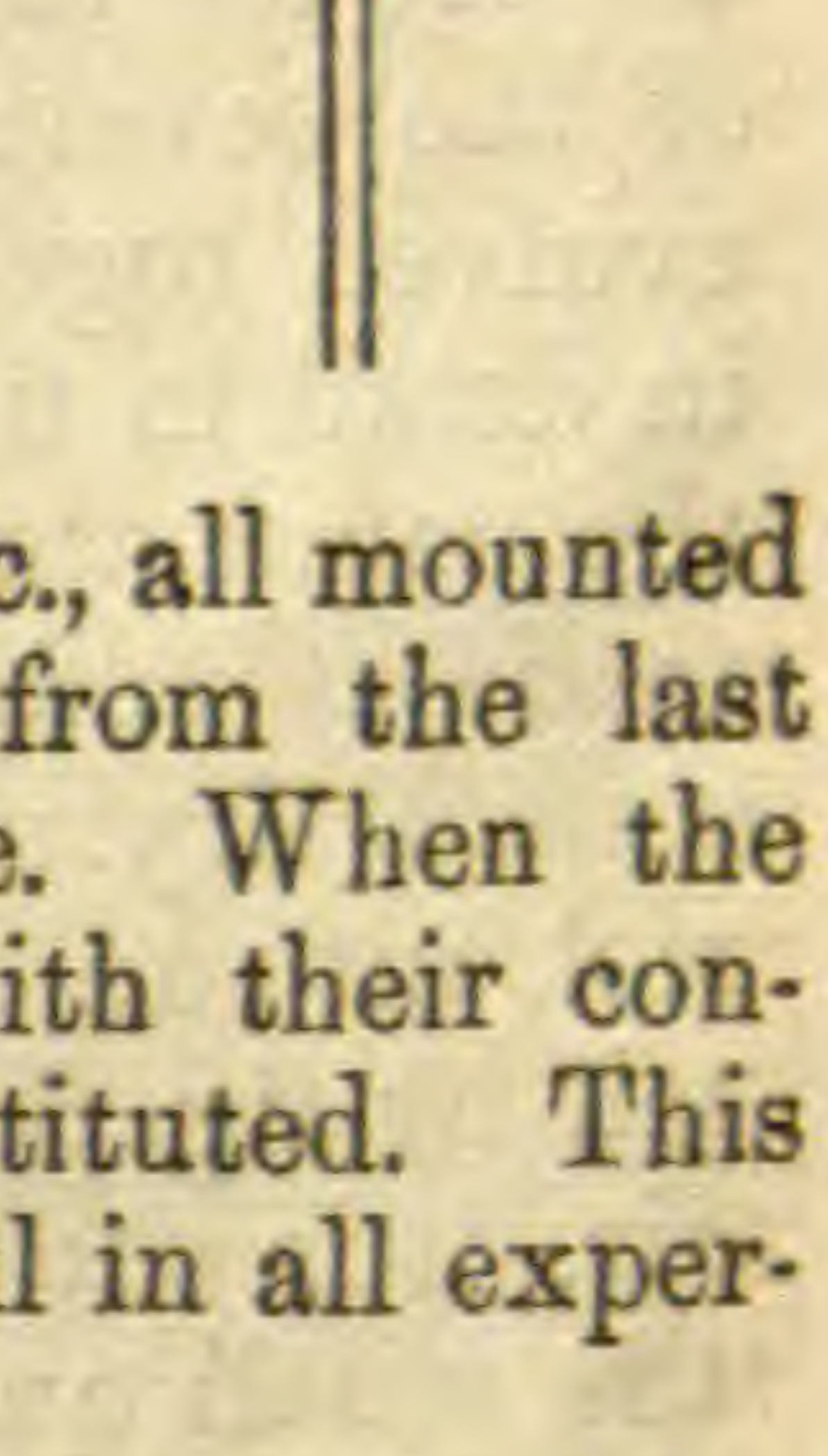

During the process of electrolysis the class will see that the two gases are evolved in nearly the same proportions, the colored gas rising in one jar as rapidly as the water falls in the other. The narrowness of the jar prevents to a great degree the diffusion of the chlorine, and a piece of white paper placed

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* The platinum wire is very easily welded to the foil on a smoothed surface of a lump of quick lime which serves as an anvil. The two having been placed together in the required position on this support are first intensely heated at the points to be united, with a blow-pipe flame, and then a quick blow with a small hammer completes the work.

behind the jar, will make the line between the colored gas and the air visible to a considerable distance. When the jars are full, the qualities of the two gases may be made evident by appropriate experiments. As is well known, the gases will not be delivered in atomic proportions, until the liquid acid is saturated with chlorine. It is best therefore not to empty the cell after the experiments, but, having removed the rubber stoppers with their attachments, to close the mouth with the ground glass stoppers, and the apparatus will then be ready for the next occasion. It is also best to interpose a small wash bottle containing sulphuric acid, between the cell and the chlorine jar, for this will not only dry the gas but also equalize the hydrostatic pressure on the two delivery tubes. Decomposing cells like that represented in fig. 1, and all other forms of glassware described in this paper are made by the New England Glass Co., of East Cambridge, and can be ordered through any of the dealers in philosophical apparatus in Boston. A much simpler decomposing cell, although not quite so efficient an apparatus, can be made with a common U tube supported on a wooden stand and mounted with rubber stoppers, delivery tubes and platinum electrodes in every respect like the other.

The second point to be illustrated in regard to hydrochloric acid is, that it consists of equal volumes of its constituent gases; and although by our first experiment, if made in the way we have described, it is shown that the gases are evolved in nearly equal proportions, yet a second experiment is required to establish the absolute truth* of this important fact. The apparatus we use for this purpose is represented in fig. 5, and the details of the several parts are shown in fig. 6. The two gases are evolved together from a simple decomposing cell, shown more in detail in fig. 9, but in connection with another apparatus, and the connection of the battery with the two electrodes, is here made as before shown in fig. 2. The mixed gases pass through a small drying tube filled with pumice moistened with oil of vitriol, into an absorption tube whose construction is shown in detail by fig. 6. As the gaseous mixture is decidedly lighter than air, it is conducted to the top of the absorption tube through the small quill tube, and overflows through the short tube below. Both of these should pass air-tight through the rubber stopper, which closes the mouth of the large absorption tube and

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* We here of course leave out of view the small difference which arises from the fact that the gases do not absolutely obey Mariotte's law and are therefore unequally condensed even by the atmospheric pressure. The volumes of the two gases would undoubtedly be exactly equal under greatly diminished pressure, but under the pressure of the air, the volume of the molecular weight of chlorine is about $\frac{1}{100}$ less than the corresponding volume of the molecular weight of hydrogen, a difference by no means inappreciable in accurate experiments.

which should therefore have a bearing on the glass of at least half an inch. It will be noticed that while the overflow tube is straight, the delivery tube is bent so that its open end is four or five inches above the mouth of the absorption tube. Rubber stoppers, or rather caps, must also be provided, by which the open ends both of the delivery and the overflow tubes may be closed at the right time. These are made by boring with a cork-borer *nearly* through an ordinary stopper and then pulling out the rubber core with a pair of pincers. The absorption tube should now be divided into two parts of equal capacity by means of rubber rings having however a length of three or four inches at the lower end for the absorbent liquid.

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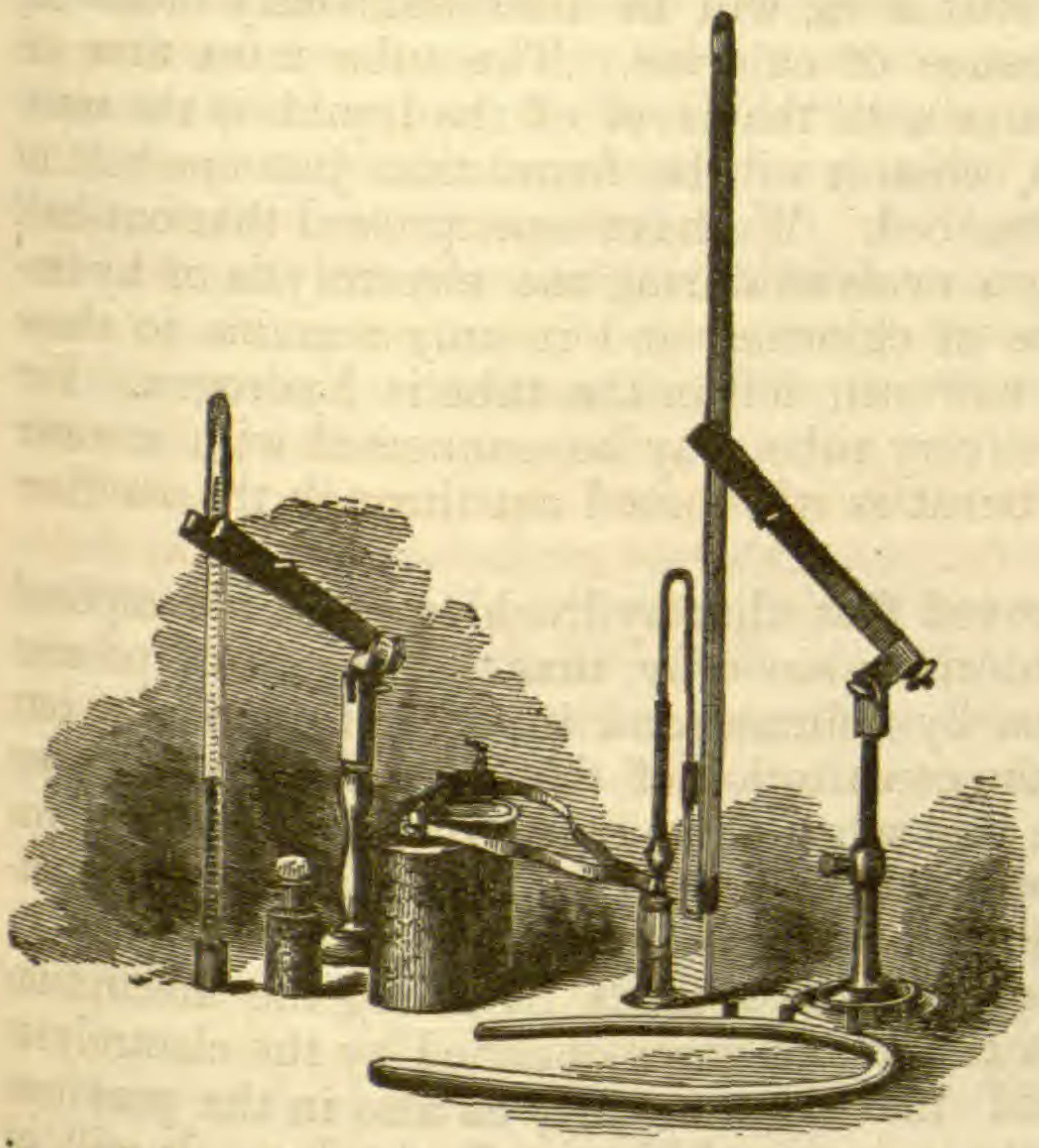

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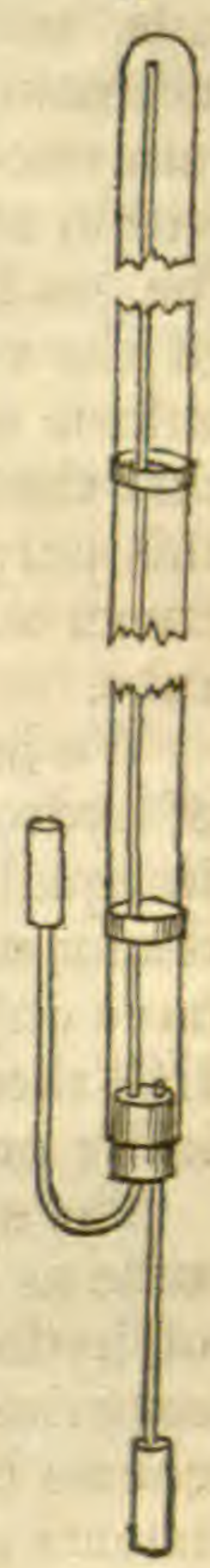

The absorption tube having been prepared as described and filled with the mixed gases, the experiment is made in the following way. The apparatus is first rapidly depressed in a solution of caustic soda (of the ordinary strength used in the laboratory) until the liquid rises in the tube to the level of the first ring. The open end of the delivery tube is now quickly closed with the rubber cap, and then the end of the overflow tube is closed in the same way—the second rubber cap having been previously dropped upon the bottom of the glass vessel containing the soda solution so as to be ready for the purpose. The tube, now perfectly air tight, is removed from the liquid and the solution of soda turned backward and forward through its entire length until the chlorine is wholly absorbed. The end of the overflow tube is now opened under water colored blue with litmus, which, as it rushes in, will be instantaneously bleached, indicating the presence of chlorine. The tube must now be immersed in the water until the level of the liquid is the same within and without, when it will be found that just one-half of the gas has been absorbed. We have now proved that one-half of the volume of gas evolved during the electrolysis of hydrochloric acid consists of chlorine, and it only remains to show that the remaining half still left in the tube is hydrogen. For this purpose the delivery tube may be connected with a water faucet and the gas burnt as it is forced out through the overflow tube.

We have now proved first, that hydrochloric acid is composed of hydrogen and chlorine; secondly, that these gases are present in equal proportions by volume, and in order to complete our demonstration of the constitution of this typical compound, we have only to prove that when these equal volumes unite to form HCl there is no condensation. This we may do either synthetically or analytically.

The synthetical experiment is made by filling the absorption tube as before with the mixed gases obtained by the electrolysis of hydrochloric acid, taking great care, as also in the previous experiment, that the tube should be perfectly dry. It will of course be necessary to have two of these tubes if both experiments are to be made in the same lecture. The tube thus filled is to be exposed for some time to bright diffused sun-light, and afterwards directly to the sun-beam until perfect combination results. If the glass is quite thick, and the rubber stopper is forced in very tight, the gases may even be exploded in the tube without danger, although this form of the experiment is always attended with some risk. When the gases are in either way thoroughly combined, the end of the exit tube is first opened under mercury, in order to prove that no condensation has taken place, and afterwards under water colored blue by litmus, when a very rapid absorption takes place, and the reddening of the water will indicate that HCl has in fact been formed.

The analytical experiment is made by decomposing HCl gas by means of sodium amalgam. For this purpose the carefully dried gas is first collected over mercury in a perfectly dry tube. This tube we assume is graduated, or at least divided into two parts of equal capacity. The tube full of gas is now slipped over the mouth of a rubber cap, which has been previously filled with the amalgam, see fig. 5 (left side of the wood cut), and sunk in the mercury trough until the liquid is just level with the brim. This cap, which is easily made from the "stopper cord," should be capable of holding ten or twenty cubic centimeters of the amalgam, and should tightly clasp the tube. Moreover for this purpose the solid amalgam, above described, should be reduced with mercury to the consistency of a thin paste. The amalgam is now to be shaken up in the tube for several minutes until the decomposition is complete, and then the mouth of the tube may be opened under mercury. The liquid will rise to supply the place of the chlorine which has been absorbed, and on sinking the tube in the mercury trough until the level is the same within as without, it will appear that exactly one-half of the volume has disappeared. As this, however, would require a deep cistern of mercury, and as the interior surface of the tube is left in such a very dirty condition as to obscure the result, we prefer to transfer the tube to a jar of water, which, when the cap is removed, at once displaces the mercury and washes out the interior, without sensibly impairing the accuracy of the experiment.

Water.—The points to be illustrated in the case of water or rather of free steam are all indicated by the equation

$$\boxed{\mathrm{H\,H}} + \boxed{\mathrm{O}} = \boxed{\mathrm{H_2O}}$$

There is no more striking experiment in this connection than the decomposition of water by sodium, but as made in the usual way the experiment is attended with no little danger. Sodium in certain states explodes violently when brought in contact with water, and after several accidents of this sort we have substituted the solid sodium amalgam above described with the best results. We place an ounce or more of this amalgam in a common gas flask and pour upon it water. The action is very moderate and must be assisted by a gentle heat, but on heating the flask with a gas lamp the gas is evolved rapidly and with great regularity. We collect it over the pneumatic trough and illustrate its properties in the usual way.

We illustrate the fact that water is composed of two volumes of hydrogen to every one of oxygen by the electrolysis of dilute sulphuric acid, using for the purpose the decomposing cell, fig. 1, already described. We collect the gases in two tall bell glasses standing side by side on the shelf of the same pneumatic trough. These bells are of course calibrated and the equal divisions marked by rubber rings. Six cells of Bunsen's battery, medium size, give a rapid evolution of gas.

Lastly we illustrate the fact, that when the elementary gases unite to form aqueous vapor, three volumes are condensed to two, by means of the eudiometer represented in fig. 7. This apparatus is easily made with a common iron casting well known to steam fitters as a "return bend." Any machinist will easily adapt this casting to the required use by attaching to it, as shown in the figure, a circular iron plate to serve as a stand, by also screwing on to one side an ordinary "elbow joint," and at the same time by carefully rimming out the three apertures so as to present smooth surfaces for the adhesion of the rubber stoppers. Into one of the openings of the "return bend" we fasten with a perforated rubber stopper, a common straight *eudiometer tube*, such for example as is ordinarily used in Bunsen's method of gas analysis, while into the second opening we fasten in a similar way an *open* glass tube. In the opening of the elbow joint we secure with a perforated rubber stopper as before, that convenient substitute for a stop cock so well known to chemists as a nipper tap. Last of all we obtain from the glass house a tubulated tube like that shown in fig. 8, of such size that it will cover the eudiometer tube and fit the upper end of the same rubber stopper by which the last is secured in its place. The upper end of this *outer tube* is also closed with a perforated stopper, as shown in the figure, and fine platinum wires, connecting with the wires of the eudiometer, pass between the stopper and the glass. The lower end of the outer tube should not fit too tightly around the rubber stopper so that it can easily be removed when not wanted, moreover all the stoppers should be made of such length that while perfectly tight, they can easily be removed for cleaning the tubes.* These rubber joints, if well made, give great flexibility to the apparatus and enable it to withstand quite rough usage.

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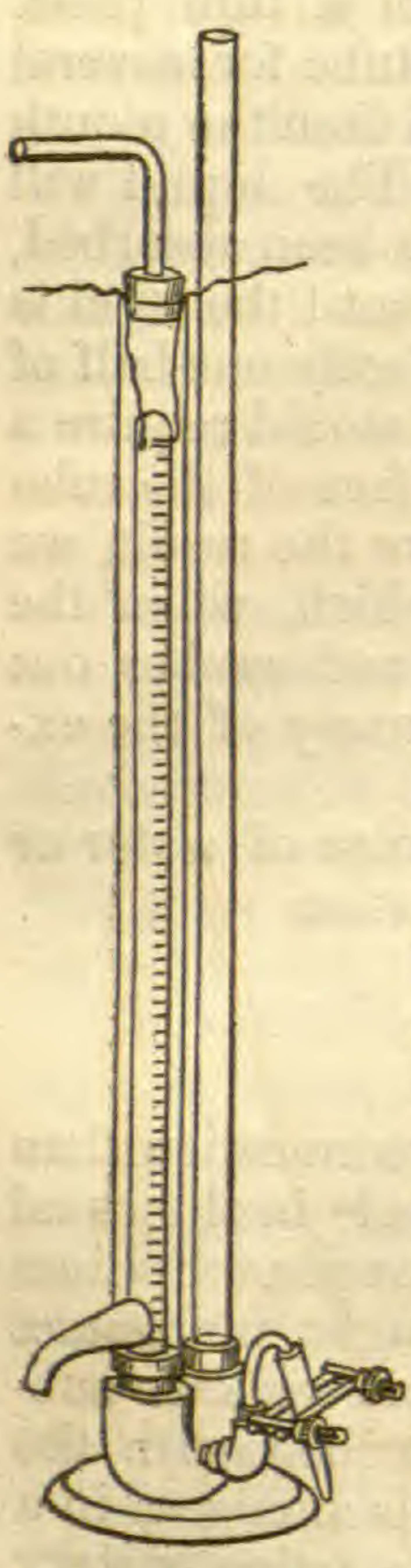

8.

The eudiometer being thus mounted, mercury is first poured into the open limb, which is then closed with a rubber stopper and the mercury transferred by inclining the apparatus to the closed limb, this process being repeated until the eudiometer

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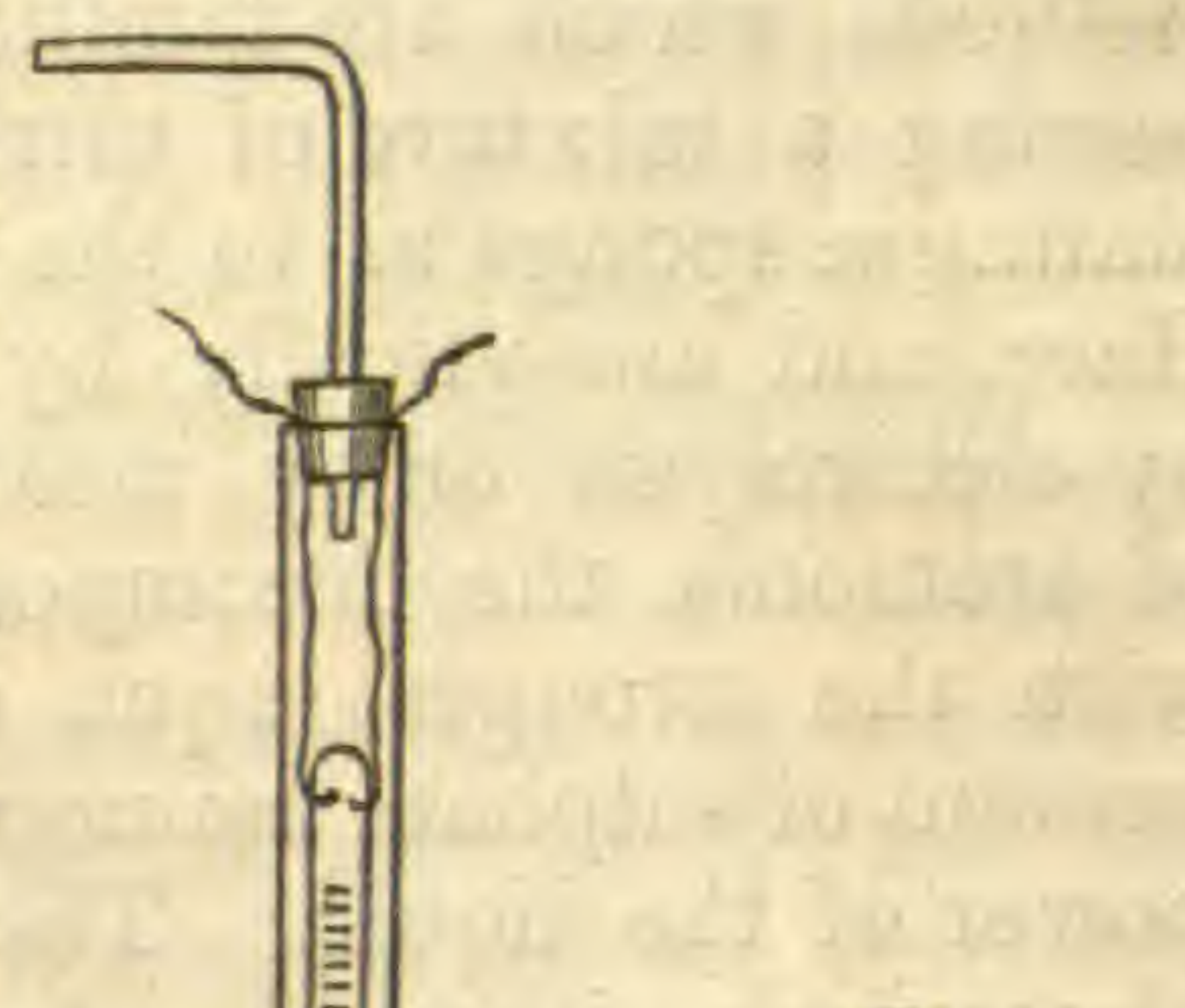
* It is also best to place around the upper end of the eudiometer tube a rubber ring, quite narrow, but sufficiently thick to fill the annular space when the outer tube is in its place, and also perforated with a number of small holes, so that the steam or vapor, employed in the experiments, may pass freely. This ring confines the eudiometer tube and gives greater solidity to the apparatus.

tube is full. The excess of mercury is now drawn out of the open tube by the tap and this tube having been removed the instrument is left as represented in fig. 9. The eudiometer is now ready for receiving the mixed gases, which are passed up into it from a simple decomposing cell, as shown in the figure, the excess of mercury overflowing into any convenient vessel. The *open tube* is now replaced and the outer tube secured in position. It is next necessary to raise the temperature of the eudiometer tube to a point considerably above the boiling point of water and maintain it at this temperature during the rest of the experiment. This is most conveniently done by passing through the *outer tube* the vapor of amylic alcohol (fousel oil,) which may be generated in a flask placed at one side and connected by a glass tube with the upper end of the apparatus. The tubulature at the lower end of the tube should at the same time be dipped into the mouth of a glass bottle into which the alcohol may flow as fast as the vapor is condensed, and since the latent heat of this vapor is very small, this simple method of condensation will be found amply sufficient.

9.



As soon as the temperature of the eudiometer tube is constant, which can easily be told, because the mercury column will then remain at a constant height, mercury must be poured into the open tube or withdrawn from it by the nipper tap until the level is the same in both limbs of the apparatus. It remains now only to note the volume of the confined gas and to explode it by passing an electric spark through the platinum wire already noticed, first, however, tightly closing the end of the open tube with its rubber stopper. When the stopper is removed and the mercury columns again brought to the same level it will be found that the volume of the confined gas has been reduced one-third. The result, however, is always a little too small, because aqueous vapor, even at the boiling point of amylic alcohol, 132° C., does not exactly obey Mariotte's law, and is somewhat more condensed than the *mixed gases* by the atmospheric pressure. It would be better to employ the vapor of a liquid having a still higher boiling point, but the results with amylic alcohol are sufficiently accurate for a lecture experiment.*

Ammonia.—The points to be illustrated in the case of ammonia are indicated by the equation $\boxed{H\ \ H\ \ H}+\boxed{N}=\boxed{H_3N}$.

We demonstrate the composition of ammonia by the old methods which are familiar to every teacher, synthetically by passing a mixture of nitric oxyd and hydrogen over heated platinum sponge as in the beautiful experiment of the late Dr. Hare, and analytically by decomposing aqua ammonia either by electrolysis or by means of chlorine. For the electrolysis of ammonia the decomposing cell fig. 1 may be used, filling it with the strongest aqua ammonia and adding a not too small amount of sulphate ammonia in order to increase the conducting power of the liquid. The reaction is less simple than in the electrolysis either of water or of hydrochloric acid, but as the final results the gasses are evolved, very nearly at least, in atomic proportions, three volumes of hydrogen to one of nitrogen. They can be collected separately in graduated bells as in the electrolysis of water. In decomposing ammonia by chlorine we use with very satisfactory results the apparatus shown in fig. 6 and already described. For this use however a tube should be selected so thin that water may be boiled in it without risk of breaking the glass. The tube having been filled by displacement with pure and dry chlorine gas, we press down the lower end into very weak aqua ammonia (eight measures of water to one of the concentrated solution,) until the liquid flowing in through the overflow tube rises to the height of the first rubber ring. We now quickly close the delivery tube with its rubber cap and allow the absorption to continue until the tube is about half full of the ammonia water when we also close the overflow tube and shake up the liquid in the large tube until all cloudiness has disappeared from the interior. The decomposition is now complete but a considerable amount of the liberated nitrogen still remains dissolved in the liquid. To expel this we heat the tube carefully over a gas lamp until the liquid within begins to boil. On now transferring the apparatus to the pneumatic trough and opening the overflow tube under water it will be found, when the tube cools, that just one-third of the original volume is left and it can easily be shown that the residual gas

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* Indeed we can obtain with free steam a result, which is sufficiently near the theory for all purposes of illustration, only it is then important that both the mixed gases and the resulting vapor should be measured under a pressure considerably less than that of the atmosphere. For this purpose a long eudiometer tube should be used and before each measurement the level of the mercury should be adjusted so that it shall stand in the open tube from 10 to 15 inches lower than in the eudiometer. Of course the difference of level must be the same at both measurements.

is nitrogen. Hence, it follows, since chlorine always combines with its own volume of hydrogen, that ammonia contains only one volume of nitrogen to every three volumes of hydrogen, the point to be proved. To complete this series of illustrations it only remains to show that in ammonia gas the four volumes are condensed to two. For this purpose some dry ammonia gas is passed up into the eudiometer tube as in fig. 9. The side tube is then replaced as in fig. 7, the mercury level adjusted and the position marked with a rubber ring. A stream of electric sparks from a Rühmkorff coil is now passed through the gas, so arranging the connections that the sparks may traverse the whole length of the gas column, and the amount of gas should be small enough to render this possible. The decomposition proceeds somewhat slowly, but after sufficient time on readjusting the level it will be found that the volume of the gas has doubled. Besides the experiments described above, there are many others, to which these same forms of apparatus are applicable; but these will suggest themselves to every teacher and it is not therefore necessary to enter into further details.

Eudiometer.—The eudiometer described above, although originally contrived for the lecture table has proved to be of still greater value in the laboratory, in all processes of gas analysis for which such an instrument is required. It is not only very cheap, simple, and easily repaired, but also equally as accurate as the the most complicated apparatus. It can be used in a room of the most variable temperature; for by passing a current of water, or of steam, as the case may require, through the outer tube the temperature of the eudiometer tube may be easily maintained absolutely constant. The various gases are passed in as shown in fig. 9 and through the same opening the reagents used in the processes of analysis are readily introduced. By replacing the open tube as in fig. 7, and bringing the two mercury columns to the same level, the residual volumes may always be read off under the atmospheric pressure and at a constant temperature, indicated by a thermometer placed in the annular space between the tubes. Or on the other hand by varying the height of the mercury column in the outer tube we may reduce the gas to the same volume and measure the difference of tension according to the method of Regnault. This form of eudiometer is especially adapted for the admirable methods of gas analysis devised by Bunsen. The absorbent balls used by him are most readily introduced when the apparatus is arranged as shown in fig. 9 and the volume of aqueous vapor formed after combustion may easily be measured by replacing the current of cold water through the *outer tube* by a current of free steam. In this case it will be best to measure the gas under as great a difference of pressure as possible, in order to ensure that all the water is vaporized and also in order to avoid the somewhat uncertain correction arising from the difference of temperature of the two limbs of the apparatus. This correction, which in most cases is insignificant, becomes important when steam is used, and it is then best to measure directly the difference of level between the mercury in the open mouth of the iron cistern, fig. 9, and that in the tube. This we do by the millimeter divisions on the eudiometer tube with the aid of a very simple contrivance. A split ring of blackened sheet brass, carrying a bent steel wire, is slipped down over the outer tube until the end of the wire just touches the surface of the mercury. The vertical height of this simple measure being known we have only to add to it the height of the mercury column above the upper edge of the ring in order to know the exact difference of level. Of course care must be taken when the measurement is made that the mercury column is vertical, but it is unnecessary to dwell on such obvious precautions, which are essentially the same with this apparatus as those so fully detailed by Bunsen in his work on "Gasometry." It is obvious moreover that the number of these corrections is considerably diminished in using this apparatus as compared with the ordinary mercury pneumatic trough, and besides the convenience and comfort of working in a warm room, it has the additional recomendation that it requires a very small amount of mercury.

The above apparatus as represented in fig. 9 may also be used with great advantage in Gay Lussac's process of determining the density of vapors. The method of using it is obvious to any one who is familiar with the process. After a weighed amount of the liquid under examination enclosed in a thin glass bulb has been passed up into the eudiometer tube it is readily converted into vapor by passing steam or the vapor of some liquid of a still higher boiling point* through the outer tube. All the measurements required in the determination are now easily made. The temperature is measured by a thermometer placed in the annular space between the two tubes and the difference of level of the mercury in the two limbs of the instrument may be most accurately determined by means of a cathetometer aided by the simple contrivance just described.

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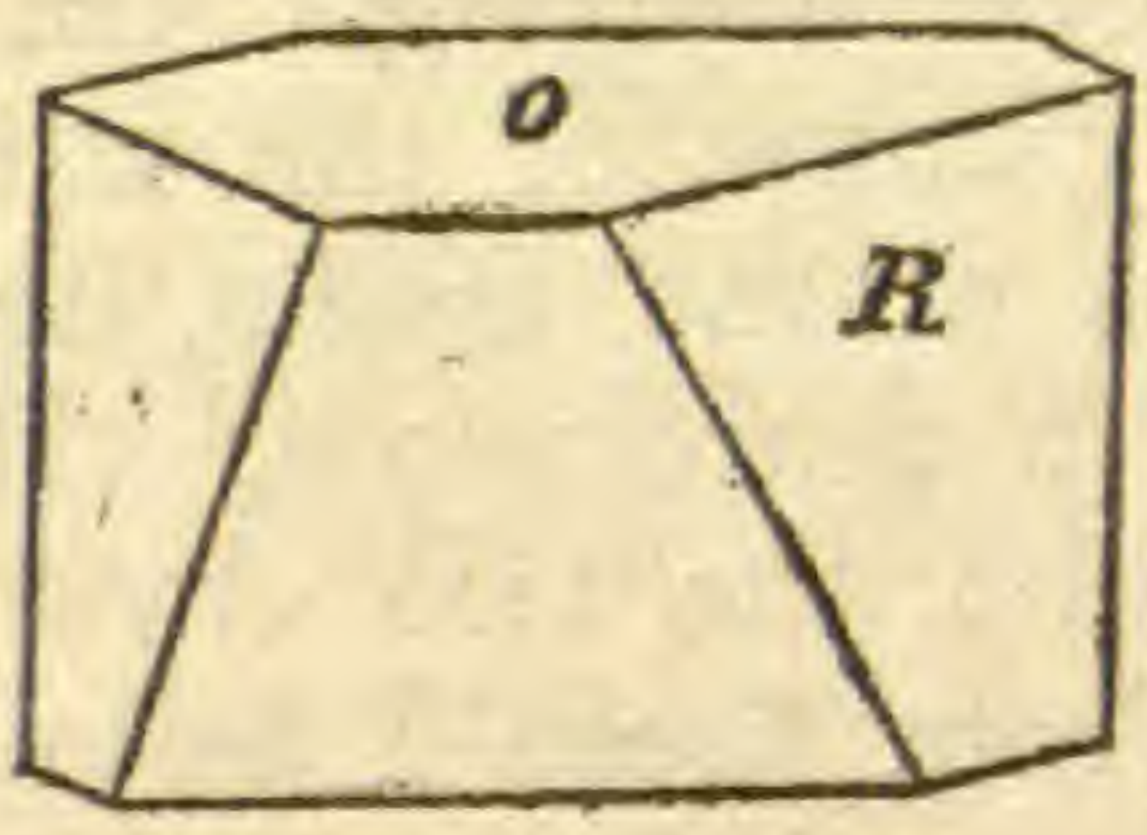
* Hydrocarbons of high but still constant boiling points, obtained by the methods of Mr. C. M. Warren, might be used with proper precautions in such determinations.

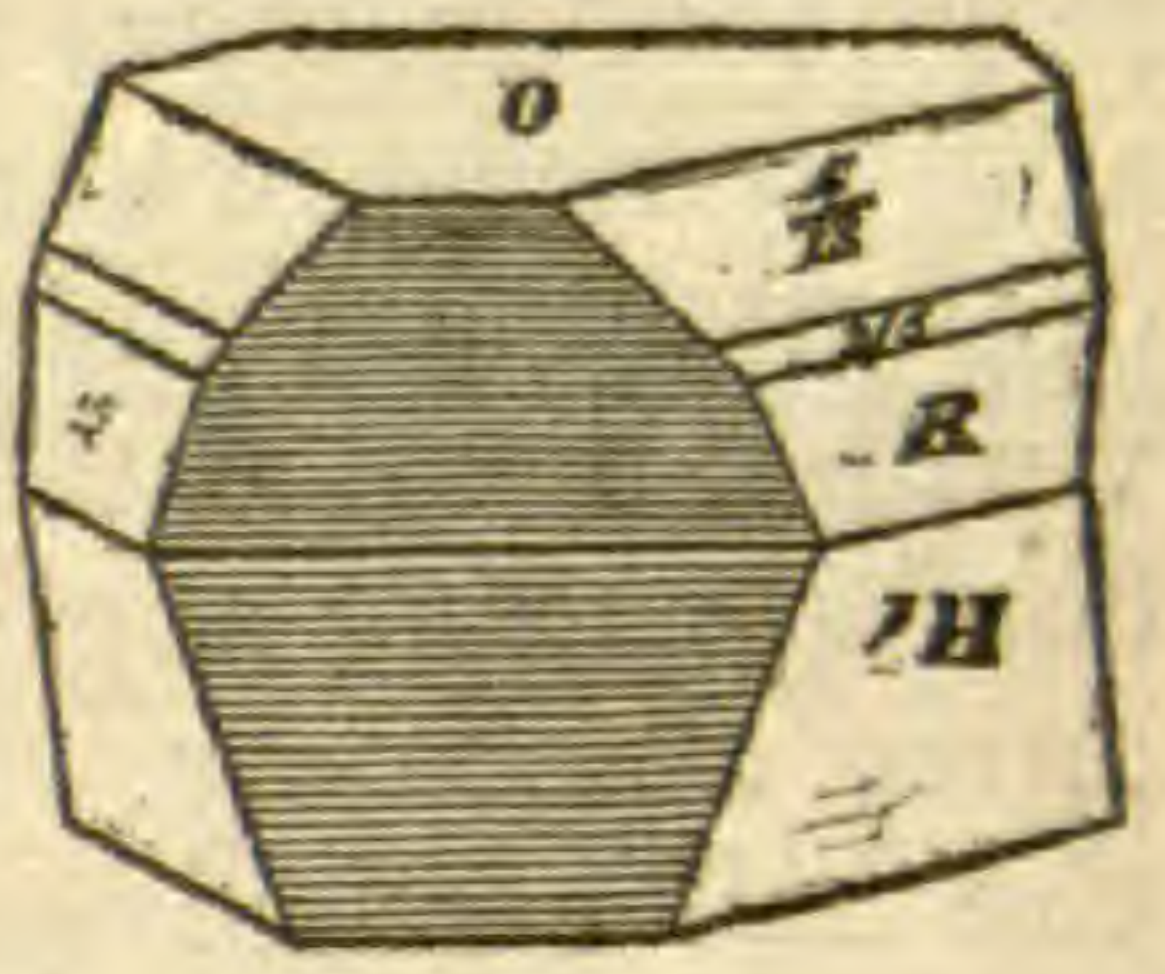
ART. XIX.—*Crystallographic Examination of some American Chlorites*; by JOSIAH P. COOKE, Jr.

THROUGH the kindness of my friend Prof. Brush of New Haven, I have had the opportunity of examining some unique specimens of the Chlorites from the well known locality at Texas, Lancaster county, Pennsylvania. My observations confirm in almost every particular, those previously made by M. Des Cloizeaux and published in his admirable Manuel de Mineralogie, tome i, pp. 433–451; but the perfection of the crystals at my disposal have enabled me to obtain a greater degree of accuracy in my measurements and also to develop some additional facts, especially by comparing the clinochlore from Texas, Pennsylvania, with that from Chester county in the same state and also with that from Chester in Massachusetts.

1.



2.



Kämmererite or Violet Chrome Chlorite.—The purest crystals of this beautiful mineral have the form represented in fig. 1. They are generally, however, macled and then appear as in fig. 2. Besides the basal plane O and the planes of fundamental rhombohedron R, these crystals also present the planes of several subordinate rhombohedrons of somewhat variable character, and in addition the basal edges of the rhombohedrons are more or less modified by the planes of hexagonal pyramids, but unfortunately the last are so strongly striated and uneven as to be wholly indeterminable. The violet Kämmererite is frequently mixed with green clinochlore, which gives to the crystals a greenish tinge. On these compound crystals the pyramidal planes are much more dominant than on the crystals of pure Kämmererite, and in this way the crystals of one mineral pass into those of the other, the violet rhombohedrons of Kämmererite merging into the green hexagonal pyramids of clinochlore. We give below in column A, the results of measurements of by far the most perfect crystal of Kämmererite we have examined. The angles italicised are certainly accurate to a minute. In columns B_1 and B_2 we give angles measured on two separate zones of a second crystal and these are important as proving the hexagonal character of the crystal. In column C, we give the fundamental angle measured on still a third crystal. The last two crystals were not so perfect as the first, but still the angles italicised must have been measured accurately within two or three minutes; so that the small differences between these values and those in column A are real variations in the angle, such as are quite common in foliated minerals. All the crystals measured were macled as in fig. 2, and we have distinguished the faces of the two members of the macle by the symbol O, R, etc., for the first, and O_1 and R_1 for the second. It is a fact worthy of notice that the faces of the same subordinate rhombohedrons are not necessarily found on both of the twinned crystals, while those of the fundamental rhombohedron are never wanting. On the first crystal we were able to measure every angle of the zone of planes between the opposite basal planes of the macle, and the observations were verified by repeated measurements. It will be noticed that the corresponding angles on the two crystals composing the macle agree absolutely. From these I have calculated the value of the half vertical axis, and from the last I have deduced the values of the angles in the column headed calculated.

$$a = 3{\cdot}4951$$

	Calculated.	Observed.			
		A	B_1	B_2	C
O on R	103° 55′	**103° 55′**		**103° 41′**	**103° 41′**
O on $\frac{4}{13}$R	128° 51′	128° 59′	**129° 6′**	**129° 8′**	
O on $\frac{2}{5}$R	121° 47′	121° 54′		122° (nearly)	
$\frac{4}{13}$R on $\frac{2}{5}$R	172° 56′	172° 55′			
$\frac{2}{5}$R on R	162° 8′	161° 59′			
R on R_1	152° 10′	**152° 10′**			
R_1 on O_1	103° 55′	**103° 55′**			
O_1 on O_1	180°	**180°**			
R on R (vertical edge)	65° 36′				

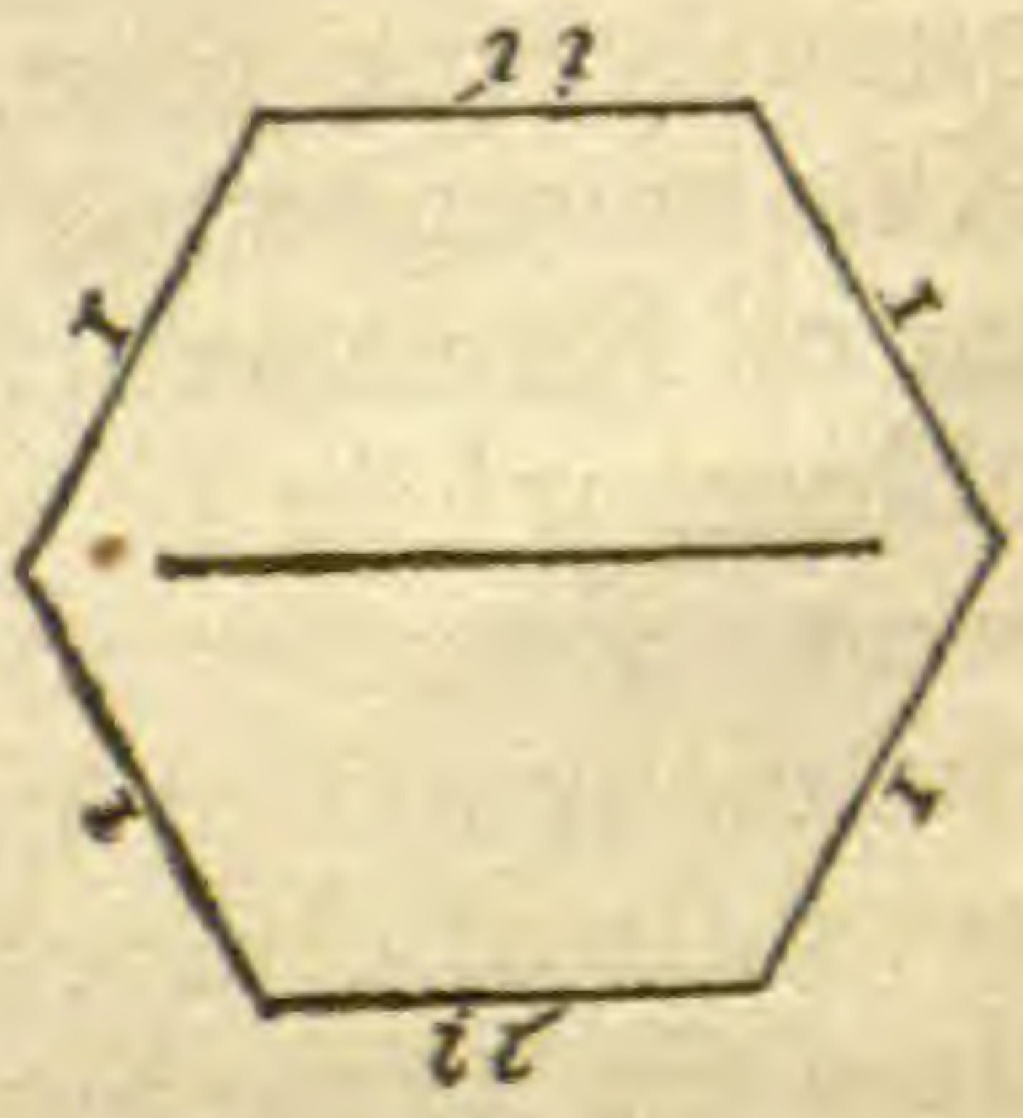
Des Cloizeaux obtained from the same mineral O on R 103° 45′, O on $\frac{2}{5}$R, 122° (about), and from the Pennine of Zermatt for O on R 103° 40′ to 50′.

Optical characters of Kämmererite.—The crystals are *uniaxial*, and the double refraction though *feeble* is distinctly *positive*. The crystals described above as No. 1, showed distinctly the first two rings with the familiar black cross. In white light these rings are alternately blue and pink surrounding a pink-colored center. In homogeneous light the rings formed by the red rays are much narrower than those formed by the blue, indicating the somewhat unusual fact that the crystal exerts the feeblest dispersive power, on the most refracted, in this case the extraordinary, beam. The crystals of Kämmererite are strongly dichroic. By transmitted light in the direction of the optical axis the color is violet; but in all directions at right angles to this, while the color of the ordinary beam is violet, that of the extraordinary is hyacinth-red. Before the blowpipe the mineral gives decided reactions both for chromium and iron.

Pale Green Chlorite.—Accompanying the specimens of Kämmererite I received a single specimen of another variety of Chlorite having a very pale apple-green color. It came from the same locality, but how closely it is associated with the violet mineral, I have not as yet been able to ascertain. The crystals are six-sided plates with an angle of 120° between the lateral edges, and the edges are beveled by the planes of a very acute hexagonal pyramid. With the exception of the color, and the strong dichroism, which is in a measure the result of the color, the optical qualities are essentially the same as those of Kämmererite. The crystals are uniaxial and they present the same *feeble, positive* double refraction. Moreover the rings formed by red light are narrower than those formed by blue light. Before the blowpipe the mineral gives a decided reaction for iron; but only a very faint reaction if any for chromium, and the difference of color is evidently connected with this difference of composition.

Clinochlore from Texas.—Intimately associated and more or less mixed with Kämmererite are crystals of clinochlore which in their purest condition have a brilliant emerald-green color. These crystals of pure clinochlore are double hexagonal pyramids, but the faces of the pyramids, are so irregular and strongly striated that it is impossible to determine the crystallographic elements of the crystals. The crystals cleave easily parallel to the basal plane and they may thus be readily divided into hexagonal plates with an angle of 120° between the lateral edges. These plates show a strong double refraction and the plane of the optical axes is parallel to the edge of the hexagonal section as shown in fig. 3. The bisectrix of the acute angle between the optical axes is positive, and inclined at a variable angle to the normal of the plane of cleavage. The angle between the optical axes is also exceedingly variable. The following angles were measured on cleavage plates from different crystals. These are not of course the true angles; but the great fluctuations of the value makes any reduction of the observations unimportant.

3.



	Apparent angle between optical axes.	Apparent angle between bisectrix and normal.
No. 1,	84°	15° 30′
No. 2,	79°	
No. 3,	67°	13° 30′

The dispersion of the axes is quite evident, and in every case $\varrho > \upsilon$. Moreover, the system of rings, when seen by white light, shows a slight but distinct difference of form at the two ends, thus indicating that the general dispersion of the system is longitudinal;* and this characteristic further indicates that the crys-

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* The modifications in the biaxial system of rings called by Des Cloizeaux "dispersion inclinée," "dispersion horizontale" and "dispersion croisée ou tournante" we

tals belong to the monoclinic system, and that the optical axes are in the plane of symmetry. These crystals of clinochlore also show a marked dichroism. The color by transmitted light in the direction of the optical axis is emerald green but in all directions at right angles to the axis, while the color of the ordinary beam is green, that of the extraordinary is reddish yellow.

The crystals of clinochlore from Texas are almost invariably macled. The ideal macle, if I may use the term, consists of three crystals interpenetrating each other, as is shown in section in fig. 4 where the portions of different crystals are distinguished by the shading, the lines of the shading indicating also the position of the plane of the optical axes. It is seldom the case, however, if ever, that the macles have the regularity, which our figure would indicate, although I have frequently observed on different parts of the same plate three different systems of rings, the planes of whose axes make angles of 60° with each other. In an intermediate position a complex form would be seen resulting from the overlapping and interfering of the three systems. Generally, however, the crystals are united in very unequal proportions, some one or two being present in very great excess and giving rise to corresponding irregularities in the figures seen by polarized light. With many plates the combined figure just spoken of would alone be seen, while with others you would see over most of the plate only one ring system, a single corner perhaps showing evidence of macling. When, as is frequently the case, the crystals of clinochlore enclose those of Kämmererite the result is still more complex. At times the crystal of Kämmererite forms the nucleus of a larger crystal of clinochlore, while in other cases these two heteromorphous minerals seem actually to interpenetrate each other; and in all cases the cleavage planes of the two crystals absolutely coincide. The crystals of clinochlore thus acquire *a violet tinge* and at the same time the angle between the optical axes is diminished. Moreover we have observed on such crystals a character not unlike that first noticed by De Senarmont on certain artificial crystals and to which he referred the variation in the angle of the optical axes of the micas. Thus on moving a plate of violet tinged clinochlore parallel to itself in front of the polarizing microscope I found that the angle between the optical axis varied as I passed from one side of the field to the other. The successive values which

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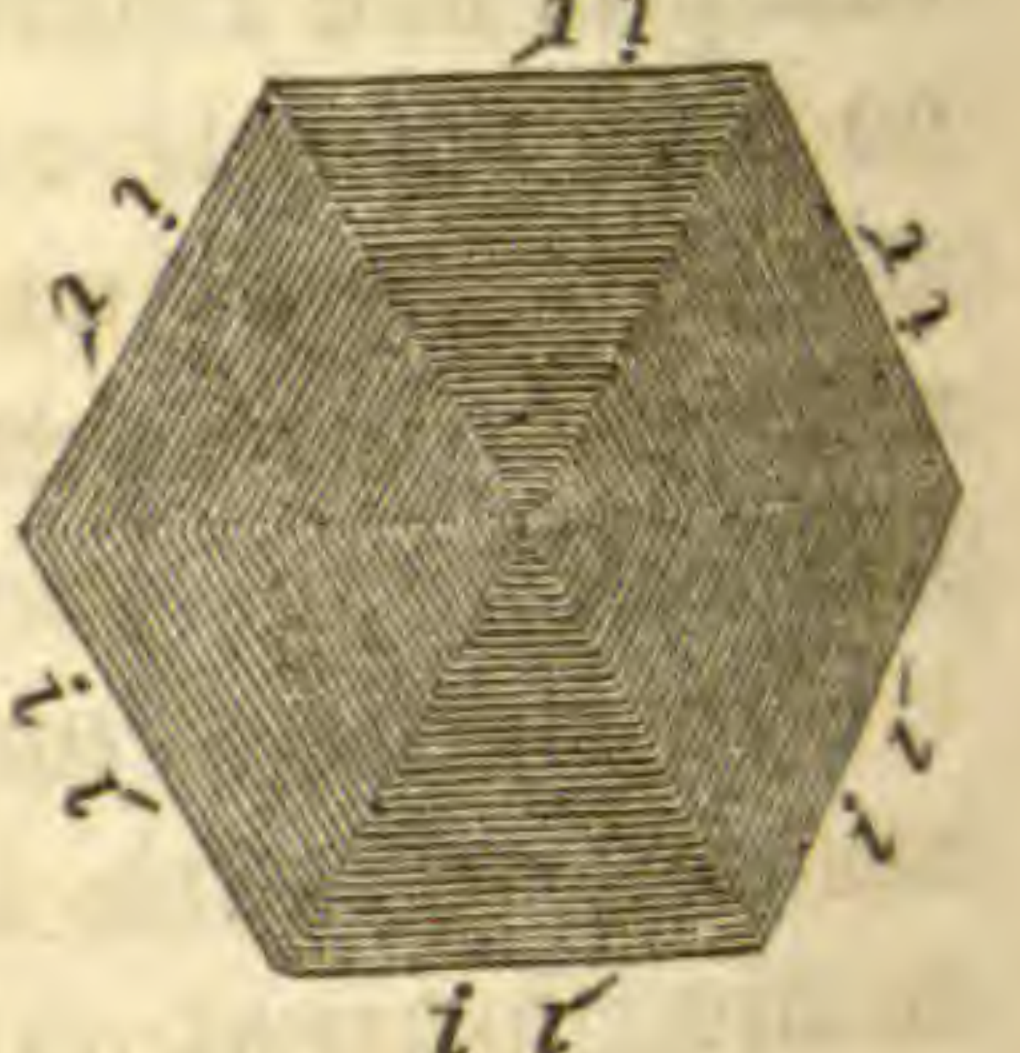

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have named in English longitudinal, lateral and circular dispersion. The English terms are not the exact equivalents of the French words, but they express the idea that the effect of light of different colors is, in the first case to move the system of rings longitudinally, in the second case to move it laterally, and in the third case to revolve it through a small angle around the bisectrix.

I obtained were 27°, 26°, 19° 30′, 18°, 17°, 16°. On another plate beginning with an angle of 30° I next measured an angle of 18°. Moving the plate still farther, always parallel to itself, the axes closed together and then again opened as I passed on to another portion of the macle. It will be noticed that the largest of these angles is much smaller than those observed on crystals of pure clinochlore, and on placing a plate of pure Kämmererite behind a plate of pure clinochlore I observed not only that the angle between the optical axes was diminished but also that the color of the light transmitted through the two plates was precisely the same as that seen through plates of the compound crystals we have been discussing.

Clinochlore from Chester county, Pennsylvania.—In connection with the clinochlore from the Chrome Iron Mines of Texas, Pa., I have reëxamined that from the serpentine of West Chester in the same state. As is well known these large crystals are so exceedingly irregular that the form cannot be accurately determined. Like other crystals of chlorite, they have an easy micaceous cleavage, and the cleavage section is either hexagonal or triangular, the angle between the adjacent edges of the section measuring 120° or 60° as the case may be. The optical characters are in most respects the same as those of the corresponding mineral from Texas. There is the same strong double refraction and biaxial character, the same inclination of the bisectrix to the plane of cleavage, the same variation in the angle between the optical axes, the same system of macles, the same color and the same dichroism; but still there is one important exception. The line uniting the centers of the biaxial image is not parallel but perpendicular to the edge of the hexagonal section as is shown in fig. 5. This fact first observed by Mr. W. P. Blake I have verified on a number of different plates, and I have not been able to find a single exception to the rule. Moreover, this position of the plane of the optical axes is preserved in the macles. An ideal section of such a macle is represented in fig. 6, where as in fig. 4 the position of the plane of the optical axes on different parts of the plate is indicated by the lines of the shading; and in some plates this ideal arrangement is very nearly preserved, although generally we find the same irregularities already noticed on the macles from Texas. Lastly, the dispersion is not *longitudinal* but *lateral*. This dispersion of the biaxial image is so slight, however, that it might be readily overlooked. It is manifested only by a slight difference in the curvature of the rings and in the

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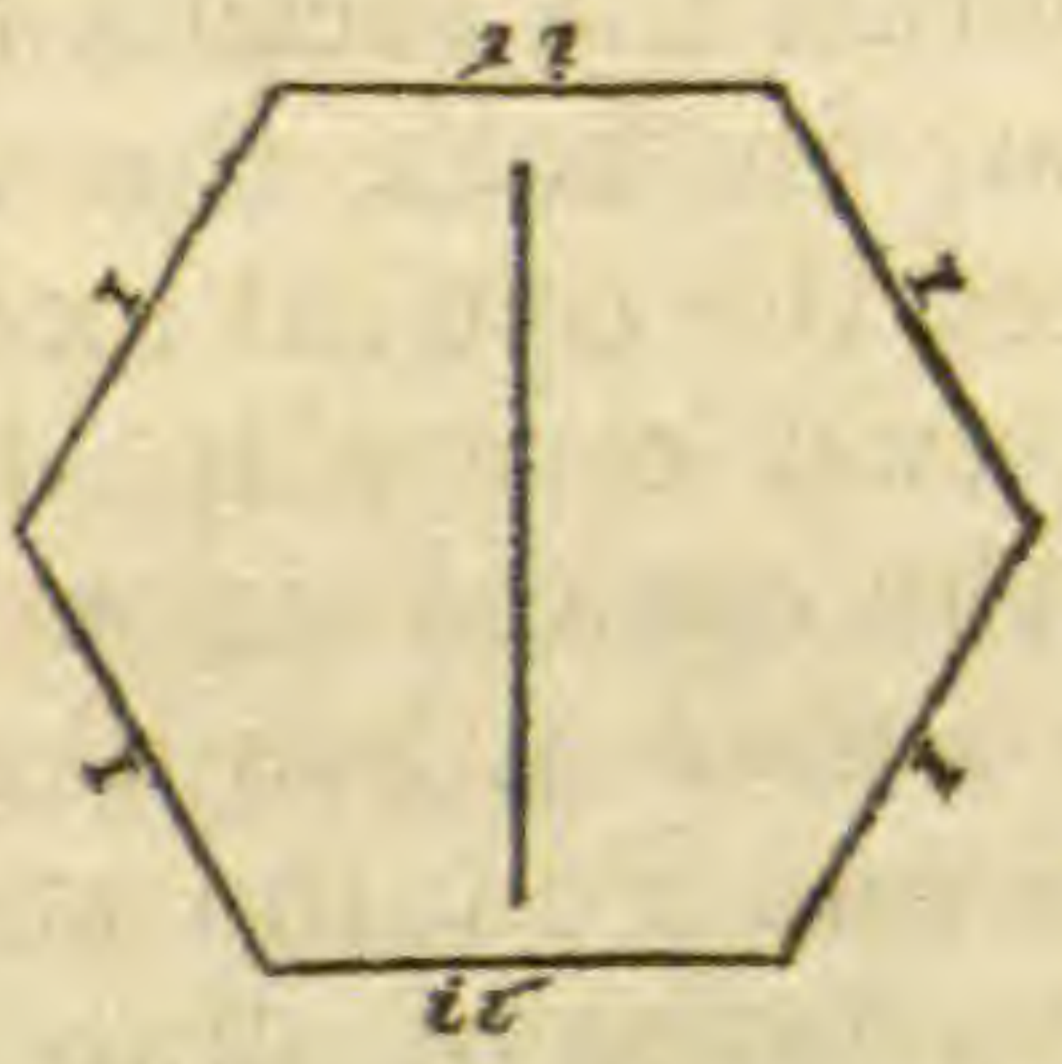

6.

intensity of their color on the two sides of the image, but then this difference is constant and after examining a large number of plates placed in different positions in the field of the microscope I was left in no doubt as to the fact. It follows then, that while these crystals are monoclinic and the position of the bisectrix is the same as in the crystals from Texas, the plane of the optical axes instead of coinciding with the plane of symmetry is at right angles to this plane.

Clinochlore from Chester, Massachusetts.—Through the kindness of Dr. C. T. Jackson of Boston I have had the opportunity of examining some well-characterized chlorite crystals, which occur at the emery mine of Chester, Mass., in connection with diaspore and its associated minerals. The crystals are double hexagonal pyramids but very rough and irregular. They have a micaceous cleavage yielding an hexagonal section, and the angle between the adjacent edges of the section measured on two different plates exactly 120°. The optical characters are all those of clinochlore; strong double refraction; biaxial image with the bisectrix inclined to the cleavage plane; and moderate dispersion of the axes $\varrho > v$. Moreover the angle between the optical axes is very variable. I measured on different cleavage plates, all from this one locality, the angles 73° 30′, 71° 30′, 45°, 32°. The line joining the centers of the biaxial image is perpendicular to the edge of the hexagonal section, and the dispersion of the image is lateral as in the crystals from Chester Co., Pa. Indeed these crystals resemble the last in almost every respect except that they are smaller, have a deeper color, and are not so generally macled.

Analogies between the Chlorites and Micas.—Although these two minerals crystallize in very different systems, yet the analogies between their crystalline characters is very remarkable. In crystals of both minerals the section made by the cleavage plane is a regular hexagon; in both, the double refraction is strong and the angle between the optical axes is very variable; in both we can distinguish two optically distinct varieties, in one of which the plane of the optical axes has the position shown in fig. 3, while in the other it has the position shown in fig. 5. Lastly Kämmererite and Pennine stand in somewhat the same relation to the two varieties of clinochlore that Vesuvian Biotite stands to the two corresponding varieties of mica, although it must be remembered, that while the double refraction of the uniaxial chlorite is very feeble that of the uniaxial mica is still quite strong. Mineralogists generally admit with DeSenarmont that the variations in the optical axes of the micas result from the mutual influence of the two optical varieties and the facts of this paper tend to show that the same influence is exerted on the chlorites.

Cambridge, June 29th, 1867.

ART. XX.—*Contributions to Chemistry from the Laboratory of the Lawrence Scientific School*, No. 3; by WOLCOTT GIBBS, M.D., Rumford Professor in Harvard University.

§ 1. *On a new general method of volumetric analysis.*

IN a memoir on the quantitative determination of nitric acid, H. Rose* suggested that in particular cases the metal in the nitrate might be precipitated by means of sulphydric acid, and the nitric acid set free determined in the filtrate by volumetric methods. So far as this application of the volumetric analysis is concerned, Rose's method appears not to have been carried out in practice or even supported by actual experiment. It occurred to me that the method might be generalized so as to form the basis of a new application of the processes of acidimetry, and the following analyses will serve to show the degree of accuracy which may be attained. When the salt to be analyzed contains a fixed acid which does not act upon sulphydric acid gas, a weighed portion is to be dissolved in water, the solution brought to a boiling heat and a current of sulphydric acid gas passed through until the metal is completely precipitated. When quantities of about 5 grams are employed the precipitation is usually complete in half an hour. The precipitate may then be allowed to settle and a drop of the supernatant liquid taken out with a glass rod and tested upon a white porcelain plate, with a drop of a saturated solution of sulphydric acid in water, or with any other reagent which may be specially adapted to the metal in the salt examined. The precipitation being complete the liquid is filtered upon a ribbed filter, the filtrate and the washings allowed to flow into a half liter or liter measure, and the washing with hot water continued until a drop of the filtrate no longer exhibits an acid reaction. The liquid is then allowed to cool and the volume made up to exactly a half liter or liter by the addition of water. After thoroughly mixing the contents of the measure, fifty or one hundred cubic centimeters are to be taken out, a few drops of a solution of cochineal or logwood added, and the free acid determined by means of $\frac{1}{10}$ normal ammonia in the usual manner. The first determination is to be used simply as a guide. Two or more successive portions of the acid liquid may then be taken out and determined successively, and the mean of several determinations obtained. With very little practice the results will be found to correspond to $\frac{1}{10}$ c. c. when a burette with Erdmann's swimmer is employed. From the quantity of ammonia required to neutralize the acid, the quantity of acid, and in many cases also of base, in the salt may be readily calculated.

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* Pogg. Ann., B. cxvi, p. 125.

With crystallized sulphate of copper the following results were obtained.

1·8435 gr. sulphate gave 81·89 p. c. acid and 31·70 p. c. base (Sharples)
3·7183 gr. " gave 32·14 " " and 31·93 " " (Sharples)
8·3955 gr. " gave 32·10 " " and 31·89 " " (Tower)

The formula $\text{ЄuꞨΘ}_4+5\text{aq}$ requires ($\text{Єu}=63{\cdot}50$).

		I.	II.	III.
ЄuΘ,	31·86	31·70	31·93	31·89
ꞨΘ_3,	32·07	31·89	32·14	32·10

The first analysis was made with a commercial sulphate, the other, with a pure salt prepared from electrotype copper. In crystallized sulphate of copper and potassium, ($\text{ЄuꞨΘ}_4+\text{K}_2\text{ꞨΘ}_4+6\text{aq.}$) 2·6601 gr. gave 18·23 per cent acid and 18·11 per cent oxyd of copper. The formula requires

		Found.
ЄuΘ,	18·00	18.11
ꞨΘ_3,	18·12	18·23

In the memoir already referred to Rose points out the necessity of diluting the solutions of metallic nitrates to such a degree that the nitric acid set free shall not act sensibly upon the sulphydric acid.

In the experiments made in my laboratory to test the method this precaution was not found to be sufficient. Thus with crystallized nitrate of lead, Mr. Sharples obtained the following results.

I. 2·147 grams of salt were dissolved in 200 c. c. water and the lead precipitated from the boiling solution by sulphydric acid gas. The filtrate was made up to 500 c. c. of which three portions containing each 75 c. c. were taken for titrition and each required 18·2 c. c. of ammonia. This gives 30·51 per cent of nitric acid, while the formula $\text{Ᵽb(NΘ}_3)_2$ requires 32·61 per cent.

II. 2·4992 of the nitrate were dissolved in 500 c. c. of water and treated as above, only the lead was thrown down in the cold by sulphydric acid, and the excess of the latter expelled from the filtrate by boiling. The acid found corresponded to 32·12 per cent in place of 32·61. From this it is clear that even dilute nitric acid acts too powerfully upon sulphydric acid to permit a very accurate determination of the former under the circumstances of the experiment. Precipitation from a boiling solution is necessary because the filtrate is then at once free from sulphydric acid.

To obviate the difficulty arising in the case of nitric acid it occurred to me to add to the solution of the nitrate a portion of a neutral salt containing a fixed organic acid, an equivalent quantity of which would be set free by the combination of the free nitric acid with the base contained in the salt. This method was found to give perfectly satisfactory results, as the following analyses by Mr. S. P. Sharples will show.

4·409 grams of nitrate of lead were dissolved in 200 c. c. of water, five or six grams of pure Rochelle salt added and the lead precipitated as above. The quantity of acid found corresponded to 32·58 per cent. The formula $\text{Pb}(\text{N}\Theta_3)_2$ requires

		Found.
$\text{N}_2\Theta_5$,	32·63	32·58
$\text{Pb}\Theta$,	67·37	67·27

0·9380 gram of nitrate of bismuth were treated as above, Rochelle salt being added. The nitric acid found, corresponded to 33·40 per cent and the equivalent quantity of oxyd of bismuth to 47·82 per cent. The formula $\text{Bi}(\text{N}\Theta_3)_3+10\text{aq}$ requires

		Found.
$\text{N}_2\Theta_5$,	33·47	33·40
$\text{Bi}_2\Theta_3$,	47·94	47·82

5·6553 gr. of chlorid of mercury were treated as above, six or eight grams of Rochelle salt being added to the solution. The free acid corresponded to

	Calc.	Found.
Cl_2,	26·20	26·10
Hg,	73·80	73·90

When chlorine is separated in the form of chlorhydric acid the volatilization of the acid in the process of boiling is completely avoided by the addition of the organic salt. The same remark applies to nitric acid, though it is probable that the principal cause of loss in this case is the action of the acid at a boiling heat upon the gas passed through the liquid. The precipitation of a metal by sulphydric acid is usually much slower when boiling solutions are employed.

The analyses given above show that, under favorable circumstances, the method employed is capable of giving satisfactory results. It is easy to see that it applies in the case of soluble definite compounds of all those metals which are easily and completely precipitated from boiling solutions by means of sulphydric acid gas. When the compound to be analyzed contains an excess of free acid not combined with the oxyd of the metal to be determined, this must be first separated by evaporation to dryness in the usual manner. The presence of alkalies and alkaline earths is of course without influence on the result, but on the other hand even very small quantities of iron, alumina and various other bases make it almost impossible to determine the point of saturation with precision, these oxyds in solution giving with cochineal and logwood specific reactions not easily distinguished from those produced by the alkalies in excess. For this reason the method does not apply when oxyds of this class are present, and this case is precisely that which most frequently occurs in practice. The method will be applicable to all these cases if hereafter a coloring matter should be discovered sensitive only to acids or bases in excess, but not producing specific coloration with salts which are neutral in constitution. It is possible that cyanin, the remarkable properties of which have been described by Schönbein, or the rosocyanin of Schlumberger,* may fulfil the condition indicated, but I have had no opportunity of experimenting with either.

The method of precipitation above described may be used with advantage in preparing a pure normal acid for titrition. Pure crystallized sulphate of copper is to be powdered and heated in a porcelain crucible placed within a Hessian crucible for about an hour, the temperature being gradually raised and not allowed to exceed a low red heat. The anhydrous sulphate is then while still hot to be transferred to a perfectly dry glass tube which can be closed with a good cork covered with tin foil. After cooling, the tube is weighed, the contents poured into a flask, the salt dissolved in water and the copper precipitated at a boiling heat as above. The filtrate and washings are then to be made up to a known volume. From the weight of the anhydrous sulphate employed the quantity of sulphuric acid present in the solution is known. In experiments made in this laboratory by Mr. R. Chauvenet this method has been found very accurate and expeditious.

§ 2. *On the precipitation of copper by hypophosphorous acid.*

In a memoir on the hypophosphites, A. Würtz† has shown that when solutions of copper are heated to 70° C. with hypophosphorous acid a hydruret of copper is precipitated, which on boiling is reduced to metallic copper with evolution of hydrogen. On repeating this experiment I found that the precipitation of copper is complete, and as the alkaline hypophosphites are now to be had in commerce, it appeared probable that the process might be applied to quantitative estimation. Experiments to determine this point have been made by Mr. R. Chauvenet with the following results:

The copper should be in solution as sulphate, the liquid containing a little free acid. The precipitation from the nitrate is always incomplete. When chlorhydric acid or chlorids are present the method fails entirely, the copper being reduced to subchlorid and remaining in solution. The solution must not be too dilute; the precipitation is complete if the saturated solution of sulphate be diluted with not more than ten times its bulk of water, before the addition of the hypophosphites. In order to avoid the sudden evolution of hydrogen gas, and also to ob-

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* Bull. de la Société Chimique, Mars, 1866, p. 194.

† Ann. de Chimie et de Physique, 3d series, vol. vi, p. 199.

tain the precipitate in a spongy coherent form, it is best not to allow the liquid to boil. The solution of hypophosphite having been added in the cold and in excess, the temperature is to be gradually raised until, after standing for some minutes between 80° C. and 90° C., the hydruret of copper has entirely separated in coherent masses. It is easy to determine when the precipitation is complete by taking out a drop of the clear liquid with a rod and testing upon a porcelain plate with a drop of sulphydric acid solution. No filter need be used if the precipitation be effected in an assay flask; the copper is easily washed by decantation, and may then be transferred to a porcelain crucible by the well-known method of inversion, dried and gently ignited in a current of hydrogen. The following analyses will serve to illustrate the accuracy of this method. In all of them hypophosphite of magnesium was employed as the precipitant.

1.	1·1650 gr.	pure sulphate of copper gave	0·2965 gr. copper	=25·45 p. c.	(Chauvenet.)
2.	1.5590 gr.	" " "	0·3970 gr. "	=25·45 "	"
3.	1·4255 gr.	" " "	0·3625 gr. "	=25·43 "	"
4.	1·3050 gr.	" " "	0·3327 gr. "	=25·42 "	(R.B.Carman)
5.	0·8208 gr.	" " "	0·2087 gr. "	=25·42 "	(E. F. Gale.)

In (4) and (5) a large excess of sulphate of nickel was present.

The formula $\text{Ȼu}\text{S}\Theta_4+5\text{aq}$ gives 25·42 per cent of copper. In the third analysis sulphates of iron, manganese, nickel and zinc in very large excess were added to the solution of copper.

I. In a very pure subsulphid of copper from Arizona, Mr. Chauvenet found in four analyses 74·24, 74·37, 74·36 and 74·41 per cent copper.

II. In an alloy of copper and nickel

6.	0·4245 gr.	gave	0·3605 gr. of copper	=84·92 per cent.	(Chauvenet.)
7.	0·3615 gr.	"	0·3070 gr. "	=84·92 "	"
8.	0·1380 gr.	"	0·1170 gr. "	=84·85 "	"
9.	0·1980 gr.	"	0·1680 gr. "	=84·84 "	"

III. In brass wire

10.	1·6300 gr.	gave	1.0705 gr. of copper	=65·67 per cent.	(Chauvenet.)
11.	1.8655 gr.	"	1·2240 gr. "	=65·61 "	"
12.	1·6770 gr.	"	1·1010 gr. "	=65·65 "	"

In the last seven analyses the alloy was dissolved in sulphuric acid, nitric acid being added from time to time to assist in solution. The solution was then evaporated until the last traces of nitric acid were expelled. The presence of iron in the form of sulphate does not in any way interfere with the complete precipitation of copper by hypophosphite of magnesium. When sesquichlorid of iron is present, however, the copper is always reduced to subchlorid and is not precipitated as metal or hydruret. A solution of a hypophosphite reduces sesquichlorid of iron to protochlorid: the reduction is particularly rapid and complete when a salt of copper is also present and the liquid contains free chlorhydric acid. I have endeavored to base upon this reduction a method for determining iron volumetrically, but all the experiments failed in consequence of the difficulty of determining the exact point at which the reduction of the iron is complete. Sulphocyanid of potassium, proposed for this purpose by Winkler* in his process with subchlorid of copper as a reducing agent, was not found to give sharp indications. When copper and iron are present together as chlorids, the addition of hypophosphite of magnesium simply reduces the copper to subchlorid as above stated. If in this case we add an alkaline chlorid to keep the subchlorid of copper dissolved, the copper may be easily precipitated as subsulphid by sulphydric acid gas. When arsenic or antimony are present with copper these must first be separated before precipitating the copper as hydruret, as careful experiments by Mr. C. Lilly have shown that both arsenic and antimony are precipitated with the copper. Mr. Lilly obtained the following analytical results when arsenous acid was present.

1·2690 gr. sulphate of copper gave 0·3279 gr. metallic copper =25·83 pr. ct. copper.
1·5127 gr. " " 0·3905 gr. " =25·77 " "
0·9638 gr. " " 0·2509 gr. " =26·03 " "

The formula gives 25·42 of metallic copper. In presence of antimonious acid—

0·7100 gr. sulphate of copper gave 0·2454 gr. copper = 34·56 per cent.

After addition of $Sb_2\Theta_3$ and Rochelle salt

0·9875 gr. sulphate of copper gave 0·2426 gr. copper = 24·56 per cent.

Repeated analyses by Mr. Lilly also showed that copper could not be determined accurately in Schweinfurt green by hypophosphite of magnesium, and that the presence of Rochelle salt did not completely prevent the precipitation of arsenic with the copper when arsenous or arsenic acid were mixed with sulphate of copper.

In assaying copper ores it is usually desirable to bring the metal at once into the form of sulphate. Numerous experiments made in this laboratory fully justify me in recommending the following method. The finely pulverized ore (sulphids of copper and iron) is to be mixed in a porcelain crucible with three or four times its weight of a mixture of one molecule of bisulphate and one of nitrate of potassium. The mixture is then to be slowly heated to low redness, which is best accomplished in a muffle. The metallic sulphids are completely oxydized without the least frothing of the heated mixture. Enough strong sulphuric acid to convert all the sulphate of potassium into bisul-

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* Zeitschrift für Analytische Chemie, Bd. iv, p. 423.

phate is then added, and the crucible is to be again carefully heated until the contents run to a clear fused mass. On cooling the mass usually separates readily from the crucible which is not attacked, and on solution the iron and copper are found completely converted into sulphates. This process has been tried successfully with a great variety of ores. The whole operation requires about an hour. In the case of ores containing much bisulphid of iron it is best to heat the powdered ore first as long as sulphur is given off, and afterward to add the oxydizing mixture and heat as above. The sulphids of lead, zinc and antimony are completely oxydized by the same process.

§ 3. *On the precipitation of copper and nickel by alkaline carbonates.*

The precipitation of copper by zinc or by the electrolytic method requires that the metal should be present in the form of sulphate or chlorid and does not succeed with the nitrate. As stated above the employment of the hypophosphites is limited to the case in which the metal exists as sulphate. The old mode of precipitating copper as oxyd by caustic potash has disadvantages which are familiar to all chemists, but on the other hand is independent of the nature of the solution of copper employed so long at least as no organic matter is present. According to Rose* the alkaline carbonates precipitate copper less completely than caustic alkalies. This statement, however, is not accurate for *all* the conditions under which the experiment may be performed; and I have found that copper may be completely precipitated from the sulphate, nitrate or chlorid when the solutions are boiled together for a sufficient time and are sufficiently dilute. Mr. E. R. Taylor, who has made a careful study of this method of determining copper, has arrived at the following as the best method of conducting the process. The solution of copper is to be diluted with water until the liquid contains not more than about one gram of the metal in one litre. A solution of carbonate of potash or soda is then to be added in small excess, and the whole boiled for about half an hour. The boiling proceeds quietly and without succussions; the blue green carbonate soon becomes dark brown, and has a fine granular character which renders it extremely easy to wash. After washing it is to be ignited in an atmosphere of hydrogen, and the copper weighed as metal; it will be found to be free from alkali. In this manner Mr. Taylor obtained in five analyses the following results:

1·8384 gr. pure sulphate of copper gave 0·4688 gr. metallic copper = 25·44 pr. ct.
1·7144 gr. " metallic cop. dissolved in aqua regia gave 1·7161 gr. cop. = 100·09 p. c.
1·3860 gr. " " " " " " 1·3853 gr. " = 99·93 "
1·4657 gr. " " " " nitric acid " 1·4670 gr. " = 100·09 "
1·4685 gr. " " " " " " 1·4634 gr. " = 99·65 "

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* Handbuch der Analytischen Chemie, ii, 175. Sechste Auflage.

The filtrate is perfectly free from copper if the process has been well conducted.

The ignited oxyd is in a state of great subdivision, and the ignition must therefore be conducted with much care to avoid loss. A small portion of the oxyd or basic carbonate usually adheres to the sides of the vessel in which the boiling takes place. This is to be re-dissolved, and again precipitated, but great care must be taken not to add a large excess of the alkaline carbonate, which gives a solution from which the copper is not precipitated by boiling.

Nickel may be completely precipitated from its solutions by precisely the same process. The green basic carbonate may be washed much more readily than the oxyd precipitated by caustic alkali; it is to be ignited and weighed as oxyd. In two analyses Mr. Taylor obtained the following results.

1·9808 gr. anhydrous sulphate of nickel gave 0·9551 gr. $\mathrm{Ni\Theta}=37{\cdot}79$ p. c.
1·4601 gr. " " " " 0·7008 gr. $\mathrm{Ni\Theta}=37{\cdot}64$ "

The formula $\mathrm{\bar{N}i\bar{S}\Theta_4}$ requires 37·69 ($\mathrm{\bar{N}i}=58$). Dr. F. A. Genth informs me that he has also used the alkaline carbonates in precipitating nickel, and with most satisfactory results.

The precipitation of cobalt by an alkaline carbonate can only with much difficulty and by long boiling be made complete. As a means of determining cobalt it is not to be recommended. On the other hand Mr. F. W. Clarke has found that cobalt is completely and easily precipitated by the process of oxydation first given by Popp,* which consists in neutralizing the solution with carbonate of sodium, adding acetate of sodium and then boiling with an excess of an alkaline hypochlorite, taking care to keep the solution alkaline. The hydrated sesquioxyd (?) of cobalt thrown down may be readily washed. After reduction in hydrogen the metal is found to be free from alkali. Nickel may, as Popp has also shown, be precipitated in the same manner, but the process given above seems to me preferable.

In this connection I may be permitted to state that the method of separating cobalt from nickel by means of peroxyd of lead attributed to myself in the new edition of Rose's† Handbuch der Analytischen Chemie and also ascribed to me by Gauhe‡ was never even proposed by me.

Cobalt and nickel may be precipitated from neutral solutions of their sulphates, nitrates and chlorids by adding first an excess of oxalic acid to the concentrated solution and then a large excess of strong alcohol. After standing a few hours the filtrate is perfectly free from metal. The oxalates are very easily washed. This method is, however, rarely available for analyt-

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* Zeitschrift für Analytische Chemie.

† Sechste Auflage, Bd. ii, p. 143.

‡ Zeitschrift für Analytische Chemie.

ical purposes, since it fails entirely when salts of ammonium or of the alkaline metals are present. The oxalates are also in such a state of subdivision that it is almost impossible to ignite them without loss. The oxyds of copper, cadmium, zinc, manganese and magnesium, are also completely precipitated from their sulphates by oxalic acid and alcohol, but not in presence of alkaline salts. The same is true of both mercurous and mercuric nitrates. In the few cases in which this mode of precipitation will find application in practice it will probably be best to determine the oxalic acid in the oxalate by hypermanganate of potash.

In a former paper I have stated that the sulphids of cobalt and nickel thrown down from boiling solutions by a boiling solution of sulphid of sodium may be washed without oxydation upon the filter. The difficulty of preparing pure sulphid of sodium has, however, been an objection to this method.* This difficulty may easily be removed by dissolving the crystallized tetrahedral sulphid, Na_2S+9aq, in alcohol of 90 per cent, filtering and allowing the solution to crystallize. After two or three crystallizations the pure sulphid may be dried over sulphuric acid in vacuo and the white effloresced mass preserved in a well stoppered bottle. The sulphid is chemically pure.

§ 4. *On the employment of sand and glass filters in quantitative analysis.*

Sufficient attention has not been paid to the advantages of filters of sand and glass over those of paper, when precipitates are to be dried upon the filter at a definite temperature. By choking the throat of a funnel with coarse fragments of glass and then placing upon these successive layers of powdered glass or sand, the upper layer being of the finest powder, it is easy to make a filter upon which almost any precipitate may be filtered off and washed out completely without the slightest loss. The funnel with its contents may then be dried at any temperature below that at which the glass softens or at which the precipitate undergoes chemical or physical change. Mr. E. R. Taylor, who has carried out this suggestion with the greatest care and thoroughness, obtained the following results in three analyses of tartar-emetic.

I. 0·0917 gr. tartar-emetic gave 0·0463 gr. $Sb_2S_3 = 36{\cdot}09$ per cent Sb.
II. 0·6236 gr. " " 0·3149 gr. " $= 36{\cdot}08$ " "
III. 0·1766 gr. " " 0·0891 gr. " $= 36{\cdot}07$ " "

The formula requires 35·92 per cent (Sb=120).

In the first and second analyses the precipitated sulphid was dried at 375° C. In the third the funnel had the shape of a tube

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* This Journal, vol. xxxvii, p. 350, also Zeitschrift für Analytische Chemie, Bd. iii, p. 392.

tapering at one end and dilated in the middle to a sort of bulb, and the precipitated sulphid of antimony after drying was ignited in the filter tube itself in a current of carbonic acid gas. This form of funnel, which is due to Mr. Taylor, will be found very advantageous. A small common funnel may be inserted into the top, and after drying, the tube funnel closed with a cork in weighing.

§ 5. *On the estimation of manganese as pyrophosphate.*

The existence of an ortho-phosphate of manganese and ammonium corresponding to the well known salt of magnesium, was long since ascertained by Otto.[*] The subject has more recently been studied by Debray[†] who has described a series of analogous phosphates, all of which are remarkable for their insolubility. Otto's salt, $P_2\Theta_8Mn_2(NH_4)_2+2H_2\Theta$, from its highly crystalline structure, the facility with which it is formed, and its insolubility, appeared well adapted to the quantitative estimation of manganese, and the following analyses show that this metal like magnesium may be advantageously precipitated as ammonia-phosphate and weighed as pyrophosphate.

To the solution of manganese, which may contain salts of ammonium or of the alkaline metals, disodic orthophosphate is to be added in large excess above the quantity required to precipitate the manganese as orthophosphate. The white precipitate is then to be redissolved in excess of sulphuric or chlorhydric acid, heated to the boiling point and ammonia added in excess. A white or semi-gelatinous precipitate is produced which, on boiling or standing for some time even in the cold, gradually becomes crystalline and finally is completely converted into beautiful talcose scales which have a pearly luster and a pale rose color. It is best to precipitate each time in a platinum vessel in which the ammonia-phosphate may be boiled for ten or fifteen minutes, and to allow the salt to remain at a temperature near the boiling point of the liquid for an hour after it has become crystalline. The ammonia-phosphate may then be filtered off and washed with hot water. The washing takes place with extraordinary facility on account of the crystalline character of the salt. The orthophosphate after drying and ignition yields pyrophosphate of manganese as a nearly white powder. In this manner

1. 0·9555 gr. $MnS\Theta_4$ gave 0·8985 gr. $P_2\Theta_7Mn_2 = 46{\cdot}68$ p.c. $Mn\Theta$
2. 1·1400 gr. " " 1·0717 gr. " $= 46{\cdot}67$ " "
3. 0·8145 gr. " " 0·7646 gr. " $= 46{\cdot}63$ " "

(Chauvenet.)

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[*] Bull. de la Société Chimique. Nouvelle Série ii, p. 11.

[†] Ann. der Chemie und Pharmacie, viii, 173.

4. 0·9464 gr. $MnSO_4$ gave 0·8886 gr. $P_2O_7Mn_2$ = 46·66 p. c. MnO
5. 1·3181 gr. " " 1·2390 gr. " = 46·68 " "
6. 1·0565 gr. " " 0·9950 gr. " = 46·76 " "

(Gordon.)

The formula requires 46·67 per cent ($Mn=54$). The sulphate employed was pure and perfectly anhydrous. In two analyses of crystallized chlorid of manganese not quite free from mechanically mixed water, Mr. F. W. Clarke obtained 27·08 and 27·07 per cent of manganese. In the same salt the percentage of chlorine was found to be 35·68 which corresponds to 27·14 per cent of manganese.

The advantage of this method over that commonly employed for the estimation of manganese, is that the process permits us to weigh the metal in the form of a perfectly definite compound and not as an oxyd which cannot be safely assumed to consist wholly of Mn_3O_4. When manganese is associated with the alkaline earths it is of course first to be separated as sulphid, or by Schiel's method as a hydrate of the sesquioxyd. The ammonia-phosphate is almost absolutely insoluble in boiling water, in ammonia and in solutions of salts of ammonium. The salt is nearly white but sometimes becomes a little more red upon the filter. If it assumes a rather deep dull red color the whole of the phosphate of manganese has not been converted into ammonia-phosphate. The precipitate is then to be redissolved in dilute chlorhydric acid, more phosphate of sodium added and then ammonia in excess, after which the boiling is to be repeated. This repetition is very rarely necessary, a little practice enabling the analyst to judge when the conversion from the flocky-gelatinous to the crystalline condition is complete. The filtrate from the crystalline salt is perfectly free from manganese. Phosphoric acid cannot be determined by precipitation as ammonia-phosphate of manganese, because the crystalline character of the salt upon which the success of the process depends is only produced by digestion with an excess of phosphate. Bette* has described an ammonia-phosphate of zinc which, like the corresponding manganese salt, is almost absolutely insoluble in water. Debray† has analyzed similar salts of nickel and cobalt, and Otto‡ has also described the analogous ammonia-phosphate of iron. I have myself prepared an ammonia-phosphate of cadmium which, like the other salts of this group, is extremely insoluble in water. All of these salts however, are more or less readily soluble in ammonia and in salts of ammonium, and after repeated trials I have not succeeded in rendering any of them available for analytical purposes.

Cambridge, June 20th, 1867.

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* Ann. der Chemie und Pharmacie, xv, 129. † Loc. cit.

‡ Ann. der Chemie und Pharm. xvi, 199.

ART. XXI.—*Note on the action of peroxyd of manganese upon uric acid;* by C. GILBERT WHEELER.

THE oxydizing action of the peroxyds upon organic substances varying to some extent according to the peroxyd employed, I have investigated the action of peroxyd of manganese upon uric acid.

If uric acid and peroxyd of manganese are heated together with a like quantity of water and sulphuric acid is added in small portions at a time until no further action is to be observed, the black pasty mass then filtered, and the filtrate evaporated to about one-fourth of its original volume, there is obtained after considerable time, a quantity of large hexagonal crystals, which by analysis and characteristic reactions was found to be parabanic acid.

If uric acid is heated with a large quantity of water only, until the latter is brought to the boiling point and then peroxyd of manganese added as long as evolution of carbonic acid occurs and the mass filtered, there remains on the filter peroxyd of manganese and oxalate of manganese, while the filtrate on being somewhat concentrated yields crystals, which if again dissolved and treated with animal charcoal may be obtained colorless and quite pure. They were tasteless, rather difficultly soluble in cold but readily soluble in warm water; the solution gave with chlorid of mercury no precipitate, while a very voluminous one was obtained on adding the nitrate of the same base; nitrate of silver and ammonia gave a white glistening precipitate; on heating, cyanid of ammonium was evolved.

0·3595 grams yielded on combustion 0·133 water and 0·398 carbonic acid; which relation indicated the substance to be *allantoin.*

	Found.	Theory.
C	30·13	30·4
K	4·09	3·8

The mother-liquor contained much urea, also an amorphous substance; the quantity of which was too trifling to admit of an analysis. The action of the peroxyd of manganese may be explained by the following exquation.

$$3(C_{10}H_4N_4O_6)+6MnO_2+8HO=2(C_8H_6N_4O_6)+2(C_2O_2H_4N_2)$$
$$+4(MnO, C_2O_3)+2(MnO, CO_2).$$

If uric acid is heated with peroxyd of manganese in the presence of but a small quantity of water there is formed urea, oxalic and carbonic acid, and but a very small quantity of allantoin; the action of peroxyd of manganese upon uric acid resembles therefore very closely that of peroxyd of lead.

ART. XXII.—*Contributions from the Sheffield Laboratory of Yale College.* NO. XV.—*Observations on the native hydrates of Iron;* by GEORGE J. BRUSH, *with analyses of Turgite by* CHARLES S. RODMAN.

THE well known iron mines of Salisbury, Conn., have long enjoyed a reputation among mineralogists as furnishing superior specimens of *limonite*, and hitherto this has been thought to be the only ferric hydrate occurring in quantity at this locality. Minute crystals of supposed Göthite have occasionally been found, but not in quantity sufficient to render certain their mineralogical determination.

On a recent visit to these mines Mr. Rodman obtained a considerable number of specimens, lining pockets in the ore, which had the usual brilliant metallic luster on the interior surface, and showed on the fracture a fibrous structure, but differed from brown hematite in having a decidedly red color, and in affording when pulverized a red powder, closely resembling that of ordinary red hematite. This red layer was in some cases an inch or more in thickness, and was deposited on a bed of limonite (brown hematite); the line of demarcation between the brown and the red ore was so perfect, in most instances, as to readily admit of a complete separation of the two minerals.

An examination of this red ore showed it to be an oxyd of iron, containing not far from five per cent of water, a number of specimens yielding very uniform results; and a complete analysis proved the mineral to be a ferric hydrate with the formula $\ddot{\bar{\mathrm{F}}}\mathrm{e}^2\dot{\bar{\mathrm{H}}}$, identical with the *Turgite* of Hermann,[*] and with Breithaupt's *hydro-hematite*, as analysed by Fritzsche.[†] The physical characters are so nearly those of ordinary anhydrous hematite that it is difficult to distinguish the species without having recourse to an estimation of the loss on ignition. The turgite yields an abundance of water when heated in the closed tube, and it decrepitates in a remarkable manner. Hardness, about 5·5. G.=4·14. For analysis the mineral was carefully dried over sulphuric acid until of constant weight, and this dessicated mineral was then heated for several hours in an air bath at 100° C. without showing any further diminution of weight. The amount of hygroscopic moisture abstracted from the air-dried mineral by treatment in the dessicator was 1·40 per cent. The iron in one instance was determined by titration with permanganate of potash; in the second case it was thrown down by ammonia, the precipitate washed, dried and weighed, and then the iron was separated from the silica and alumina by Deville's

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[*] Journal für praktische Chemie, xxxiii, 97.

[†] Breithaupt, Vollständiges Handbuch der Mineralogie, iii, 846.

method by first reducing with hydrogen, and subsequently volatilizing the iron by heating in a current of dry hydrochloric acid gas. The analytical results were all obtained by Mr. Rodman. Composition:

	1.	2.	Mean.
Ferric oxyd, - - -	91·45	91·29	91·36
Manganic oxyd, - -	0·67	0·55	·61
Alumina, - - - -	0·75	....	·75
Silica, - - - -	0·22	0·24	·23
Phosphoric acid, sulphuric acid and cobaltic oxyd,	traces	....	traces
Insoluble in acid, - -	1·83	....	1·83
Water, - - - -	5·20	5·21	5·20
	100·12		99·98

Other determinations of water on different specimens gave 5·02 and 5·09 per cent.

Five grams of the mineral yielded only minute traces of sulphuric acid, and three grams showed but an unweighable trace of phosphoric acid. A very perceptible trace of cobalt was found even on examination of one gram of the mineral. The portion insoluble in acid proved on analysis to consist entirely of silica, and excluding this, with the small amount of silica and alumina found in the soluble portion, the result of the analysis is

$$\begin{array}{llll} & \overline{\overline{\mathrm{Fe}}}\ 94{\cdot}00 & \overline{\overline{\mathrm{Mn}}}\ 0{\cdot}63 & \dot{\mathrm{H}}\ 5{\cdot}35 = 99{\cdot}98 \\ \text{Oxygen,} & \multicolumn{2}{c}{\underbrace{28{\cdot}20 \qquad\qquad 0{\cdot}19}_{28{\cdot}39}} & 4{\cdot}75 \end{array}$$

giving the oxygen ratio 6 : 1 or $\overline{\overline{\mathrm{Fe}}}^2\dot{\mathrm{H}}$.

This result confirms the conclusions of Hermann and Breithaupt that there is a native ferric-hydrate with one-half an equivalent of water. Several years since the attention of the writer was called to this subject by Prof. W. T. Roepper, of Bethlehem, who stated that he had found Breithaupt's hydrohematite to be of frequent occurrence with the limonite ores of the Lehigh valley. A water determination on the Lehigh mineral made by Prof. Roepper, and kindly communicated for this article, gave 5·34 per cent, and Prof. Roepper calls especial attention to the characteristic decrepitation of this mineral when heated. On examination of the specimens of limonite in the Yale College collection, a fine specimen of the red hydrate was found occurring with the limonite of Düsseldorf in Prussia, this yielded on examination by Mr. Rodman 4·75 pr. ct. water. Another specimen was found from Ioditz in Bavaria, besides numerous specimens from Salisbury in Connecticut. A mineral of like composition has also been found by Bergemann* at the Louisa Mine near Horhausen in Prussia. From these numerous

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* Rammelsberg, Handbuch für Mineralchemie, 988.

localities it would appear that the mineral is of common occurrence. It has heretofore been confounded by most mineralogists with hematite which it so strongly resembles in physical characters. It may be readily distinguished from hematite by simply heating a fragment in the closed tube, when it decrepitates violently and gives off a large amount of water.

Hermann does not give the pyrognostic characters of *turgite*, but Breithaupt in his description of *hydro-hematite* makes particular mention of its characteristic decrepitation when heated. The turgite is described by Hermann as being associated with copper ores; its chemical composition is however identical with hydrohematite, and as it has priority of publication the species must bear the name of turgite, and hydrohematite be used only as a synonym.

We have therefore three well defined hydrates of iron occurring native and forming three distinct and well-established mineral species, differing from each other in physical characters and in their relative content of water.

Turgite,	$\overset{\cdots}{\bar{F}}\mathrm{e} + \tfrac{1}{2}\dot{\bar{H}}$
Göthite,	$\overset{\cdots}{\bar{F}}\mathrm{e} + \dot{\bar{H}}$
Limonite,	$\overset{\cdots}{\bar{F}}\mathrm{e} + 1\tfrac{1}{2}\dot{\bar{H}}$

Two other hydrates have been described containing respectively two and three atoms of water. Murray* found in a brown iron ore from Hüttenrode in the Hartz—

$\overset{\cdots}{\bar{F}}\mathrm{e}$ 81·41, $\dot{\bar{H}}$ 17·96, $\overset{\cdots}{\mathrm{Si}}$ 0·17, Carbon 0·46=100, giving the formula $\overset{\cdots}{\bar{F}}\mathrm{e}+2\dot{\bar{H}}$.

A compound of similar composition from Kilbride in Ireland, having a pitchy color, analyzed by Haughton, gave—

$\overset{\cdots}{\bar{F}}\mathrm{e}$ 77·15 $\dot{\bar{H}}$ 20·43 $\overset{\cdots}{\mathrm{Si}}$ 0·30 $\overset{\cdots}{\bar{A}}\mathrm{l}$ *tr.* $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}}$ 1·60 = 99·48

Xanthosiderite also appears to be a mineral of like composition, but its mixture with a silicate of unknown composition renders it difficult to conclude positively that it belongs here.

A. H. Church† has analyzed a stalactite of a rust-colored ferric hydrate from Botallack mine in Cornwall, which gave—

$\overset{\cdots}{\bar{F}}\mathrm{e}$ 73·73, $\dot{\bar{H}}$ 24·40, loss, $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}}$, and organic matter 1·76 = 100, giving the formula $\overset{\cdots}{\bar{F}}\mathrm{e} + 3\dot{\bar{H}} = \overset{\cdots}{\bar{F}}\mathrm{e}$ 74·77, $\dot{\bar{H}}$ 25·33.

Other analyses of ferric hydrates by many different analysts, and from a great range of localities, give an amount of water which correspond to one or the other of these last two hydrates; but as these contain also either organic matter, phosphoric acid, or silica in the combined state, it is impossible, without further investigation, to know to what hydrate to refer them.

The artificial ferric hydrate precipitated by ammonia from ferric chlorid varies in composition according to the method of

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* Rammelsberg Mineralchemie, 150.

† Journ. Chem. Society, II, iii, 214.

treatment. Schaffner obtained a hydrate with 1 atom, Gmelin with 2 atoms, and Wittstein with 3 atoms of water; this last kept for some time under water became crystalline and was converted into a hydrate with 1½ atoms of water. Recent investigations by E. Davies* show that the ordinary precipitated ferric hydrate loses water on being boiled in water; in one case the amount of water was reduced to 3·52 per cent. Similar experiments conducted in this laboratory by Mr. Rodman showed that by continued boiling in water the amount of water remaining in the hydrate could be reduced even to 2 per cent. These facts, as Mr. Davies suggests, explain in a very satisfactory manner the association of the different ferric hydrates in nature and do not necessarily demand the supposition of great heat to account for the large beds of anhydrous hematite found in different parts of the world.

Sheffield Laboratory, February, 1867.

ART. XXIII.—*On a new Test for Hyposulphites;* by M. CAREY LEA.

IN an examination of the platinum metals which I published some time back in this Journal, I described a very delicate test for ruthenium, by which the faintest traces of that metal could be detected through the agency of hyposulphite of soda. Recently, having occasion to test for the last-named substance, it occurred to me as probable that ruthenium might be rendered available for that purpose. This I found to be the case, and that the reaction exhibited considerable delicacy. It is true that ruthenium is at present a very rare metal, and not within the reach of all who might wish to use it, but the changes from rarity to more or less abundance are now so common and sudden that present scarcity is no reason for ignoring any useful reagent.

When a solution of ruthenium is rendered alkaline by ammonia and boiled with hyposulphite of soda, it gradually assumes a rose color which passes into a rich carmine; with strong solution the color is so intense as to be almost black. When diluted the shade is magnificent, rivalling the aniline red in richness.

I have already stated within what limits ruthenium can be detected by hyposulphite of soda. I now subjoin the limits observed with respect to hyposulphite of soda.

A solution containing one four-thousandth of hyposulphite, gave a clear rose red.

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* Journ. Chem. Society, II, iv, 69.

One containing one twelve-thousandth gave a well marked pink liquid.

One containing one twenty-five-thousandth gave a salmon color.

The experiment was not carried further because the salmon color in the last-mentioned trial showed that the test had then reached its practical limit. I do not doubt that even with one hundred thousandth a coloration could be obtained, but it would not have the specific distinctness given by the carmine and rose shade previously described.

A few words remain to be said as to the best mode of applying this test.

I have recognized in solutions of sesquioxyd of ruthenium a strong tendency to decompose by dilution: dilute solutions have a strong tendency to gradually deposit their ruthenium as oxyd. And even before the slightest sign of a precipitate appears, in fact immediately upon dilution, solutions show a tendency to change their reactions. So that I find it invariably better on diluting the ruthenium solution for use in testing, to boil it (as I have elsewhere pointed out in speaking of the dilution of ruthenium) with a few drops of hydrochloric acid, and this even although the solution is to be immediately afterward rendered alkaline by ammonia. To ascertain with certainty that this improved the delicacy of the reaction, I made comparative experiments on two portions of the same ruthenium solution, and found that the coloration by hyposulphite was at least three times stronger in the case of the portion that had been boiled with HCl than with that that had not.

As ammonia was thereafter immediately added, it might appear that the function of the hydrochloric acid was to form hydrochlorate of ammonia. But it was found by experiment that the addition of sal-ammoniac in no way aided the reaction.

The addition of ammonia to a hot solution of sesquichlorid of ruthenium immediately darkens it to a blackish olive color, which, according to the dilution and the light that falls on it, is of a reddish or a greenish shade. By standing, the ruthenium is precipitated as oxyd. As this condition is the necessary preliminary (as before explained) to the production of the characteristic carmine reaction, it is not a little singular that the delicacy of that reaction should be so greatly enhanced by taking steps to strengthen the combination with excess of acid and boiling, immediately before the affinities are to be loosened by ammonia.

In using this reaction for the detection of small quantities of hyposulphite, it is useful to remark that it succeeds best when very little ruthenium is present. After the ruthenium solution has been boiled with acid and supersaturated with ammonia, and the liquid to be tested for hyposulphite added, the mixed solution should have so little ruthenium in it as to exhibit only a very pale transparent olive coloration—should in fact be *almost* without color. Otherwise if the hyposulphite is present in mere traces, we get a salmon or flame color instead of the pure carmine.

ART. XXIV.—*Contributions to Chemistry from the Laboratory of the Lawrence Scientific School.* No. 4.—*On a new mineral from Rockport, Mass.;* by W. J. KNOWLTON.

IN the March number of this Journal for the present year, Prof. J. P. Cooke has described as malacone a mineral discovered by myself at Rockport, Mass., where it occurs in the granite in veins of massive quartz and feldspar. Prof. Cooke's analysis was made, as he states, upon a small quantity of material and he speaks of it as "imperfect"; he found

Silica, - - - - - - - -	27·90
Zirconia, - - - - - - -	66·93
Sesquioxyd of iron, with trace of manganese, -	2·57
Water, - - - - - - - - -	2·19
	99·59

which results, if correct, would unquestionably identify the mineral with malacone. I have repeatedly analyzed this mineral, and my results differ, as will be seen, so much from those of Prof. Cooke, and from the analyses of malacone hitherto published, that I am disposed to consider the mineral as a new species. If this conclusion be admitted, I propose for it the name of *Cyrtolite*, (from ϰυϱτος, *curved*,) in allusion to the very marked curvature of the terminal faces which is observed in the great majority of specimens. The mineralogical characters of cyrtolite have been already described by Prof. Cooke. It is almost always found imbedded in massive feldspar, sometimes in large aggregates of crystals, sometimes in single crystals which are often quite perfect. Fine single crystals are found at various places on the sea-shore where the veins have been exposed by the action of the water. The luster of the crystals is often brilliant, but fracture exhibits a dull brownish-red color. In three determinations of the specific gravity of cyrtolite by Rose's method, I found 3·850, 3·856 and 3·970; the last determination being made upon a specimen from a somewhat different locality, and taken from the surface rock near the shore.

Before the blowpipe cyrtolite glows brilliantly, and is but slightly altered in color. Its powder dissolves rather easily in borax, giving a distinct reaction for iron. With microcosmic salt it dissolves partially, leaving a white siliceous skeleton. Prof. Cooke states that the mineral is easily and completely resolved by fusion with alkaline carbonates. I have not obtained the same results, but have on the contrary found it very difficult to decompose it completely in this manner; even fusion for several hours with four times the weight of a mixture of carbonate of potash and carbonate of soda failing to produce a perfect resolution. Four consecutive fusions with the alkaline mixture gave but little better results. In another analysis, after fusing for three hours with the alkaline mixture, treatment of the fused mass as an ordinary silicate with chlorhydric acid, and fusion of the silica obtained a second time, there remained 2·20 per cent of earth which could not be further purified by treatment with fluorid of ammonium and sulphuric acid.

When heated with sulphuric acid in a closed tube for two or three hours to a temperature of 210° C., about 33 per cent of undissolved matter remained. On diluting, filtering and boiling the filtrate, from 8 to 13 per cent were precipitated in different experiments, according to the quantity of free sulphuric acid in the solution. When fused with bisulphate of ammonium the mineral is completely decomposed, but it is difficult to avoid loss by spattering. Bisulphate of potash also completely resolves the mineral by fusion, but forms with the zirconia the well known double sulphate which dissolves with much difficulty; bisulphate of soda would doubtless be preferable, but I have not employed it in quantitative analyses. The mineral is more readily resolved by fusion with fluorid of ammonium and subsequent treatment with sulphuric acid. The decomposition is perfect, but of course the silica must be estimated by loss. In four analyses I obtained the following results:

	No. 1.	No. 2.	No. 3.	No. 4.
Silica,	26·29	26·37*	26·48*	26·18
Zirconia,	61·33	61·00	60·00	64·60†
Cerium metals,	2·24	1·80	2·19	1·40
Iron, FeO,	3·65	3·63	3·60	....
Uranium, Ur_2O_3,	....	1·94	2·83	1·40
Tin, with trace CuO,	·35	·70	·35	·41
Water,	4·58	4·55	4·55	4·58
Trace manganese and magnesia,	....	....	....	....
Trace of fluorine,	....	....	....	....
	98·44	100·00	100·00	98·97

In these analyses the water was determined by heating the

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* Silica estimated by difference.

† In this analysis the zirconium and iron were not separated.

mineral in a platinum tube in a current of carbonic acid. The silica was estimated in the first analysis by fusion with bisulphate of ammonia, and in the last by fusion with the alkaline carbonates and subsequent treatment with fluorid of ammonium and sulphuric acid. In the second and third analyses, it was determined by loss. Tin and copper were precipitated by sulphydric acid gas. After oxydizing the iron, the iron and zirconia were precipitated together from the nearly neutral solution by acetate of soda. The iron was then separated from the zirconia by Deville's method for the separation of iron and alumina. In the filtrate from the iron and zirconia, the cerium metals were precipitated by oxalic acid, and the uranium by ammonia. It is not easy to determine in what state of oxydation the iron and uranium exist in the mineral. I have taken the iron perhaps arbitrarily as protoxyd and the uranium as sesquioxyd. In the second and third analyses the uranium was not perfectly separated from zirconia.

It scarcely admits of a doubt that the zirconia in cyrtolite is associated with another and similar oxyd—perhaps titanic acid. When the zirconia is strongly heated in a platinum tube in a current of hydrogen gas the earth assumes a bluish color resembling that seen in niobic and titanic acids when similarly treated. The color disappears on heating the blue mass in the air. If we add to an acid solution of zirconia from cyrtolite—a solution of the earth in fluohydric acid is best—sodium amalgam, magnesium or zinc, a purple or dull violet color is soon observed, sometimes with a precipitate of the same color. In the absence of any method of separating zirconia from titanic acid, &c., quantitatively, I must leave the precise constitution of the metallic acids in cyrtolite undetermined. I am very far from supposing that my analyses of the mineral leave nothing to be wished, but in the absence of good and thoroughly tested methods of analysis, I have done all in my power to obtain correct results.*

Cambridge, June 29th, 1867.

ART. XXV.—*On the subdivisions of the Cretaceous rocks of California;* by WM. M. GABB.

SINCE the publication of the first volume of the California Reports on Paleontology, there have appeared several rather severe, and not altogether good natured criticisms. These have culminated in the publication by the Smithsonian Institution of

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[*] I may be permitted to mention in this connection that I have found *cæsium* in the cryophyllite from Rockport, described by Prof. Cooke. The alkali is easily detected by the spectroscope in the alums obtained from the mineral, but its quantity is very small—much less apparently than that of rubidium.—W. J. K.

a pamphlet purporting to be a check list of Eocene fossils, prepared by one of our oldest Paleontologists. So eminent an authority and the endorsement of so respectable an institution require that I should say something in vindication of the position I have taken, and give to the scientific world the grounds on which I base my deductions.

The rocks of California, included by the Geological Survey under the general head of Cretaceous, can be easily separated into two well-marked divisions. Our acquaintance with them has not yet been sufficiently detailed to attempt a further separation into sub-groups, though, in the older members, that can doubtless be done hereafter. This older group is without doubt the equivalent of the No. 5 and the upper part, if not the whole of No. 4 of Meek and Hayden's Nebraska section. There may be, and in fact probably are, older members of the Cretaceous formation represented in California, but our information is, as yet, too limited to make the assertion positively. In the northern part of the state, where these rocks have been least studied, isolated specimens have been obtained with a decidedly "Neocomien" aspect. The more recent member, always conformable with the lower, and connected with it by a series of strata not very fossiliferous, appears to be the American representative of the Maestricht beds, the 'Danien' of the French authors. The position of the older group is universally conceded, and it only rests with me to establish that this newer group is without doubt Cretaceous and not Eocene as Mr. Conrad originally asserted and still maintains.

It has many points in common with the Maestricht beds of Europe. It contains but a single species, so far as known, of the complex-chambered group of Cephalopods. A solitary ammonite, represented by half a dozen specimens, has been found by myself, in place, even to the very top of the formation.

The rocks which I included in my Division B, are found in and more particularly along the eastern face of the Coast Ranges over an extent of upwards of four hundred miles. They are in many places metamorphosed, but are in a number of localities highly fossiliferous. The principal localities from which fossils have been collected are—the vicinity of Fort Tejon, New Idria, near Griswold's on the road between New Idria and San Juan, Clayton at the Monte Diablo coal mines, Martinez, San Diego and on one of the forks of Eel river near Round Valley, Mendocino county. At Clayton and Martinez they are connected with Division A by a regular succession of intermediate beds but containing very few fossils. Near the village of Lower Lake, Lake county, these intermediate beds are again developed and are then highly fossiliferous.

In the California Cretaceous rocks we have already recognized and described 280 species, besides about fifty species not yet described but of which we have sufficient material for publication, and about 30 or 40 species, the existence of which is indicated by fragments too imperfect for description. Of these species 107 are found in Division B. Of these 107, 84 are, so far as known, peculiar to this group, and 16 are found in common in undoubted members of both divisions, while 7 more are found in the intermediate beds associated with a nearly equal number of representatives of the lower group. Thus the two groups are connected by a passage of nearly one-fifth of all the species found in the upper member.

The following analysis will prove the above statements more clearly.

Of the 107 species of fossils found in Division B, 44 are found at Clayton, 67 at Tejon, 54 at Martinez, 22 at San Diego, 18 near Griswold's, and 7 near New Idria. It is not intended to be understood that these are all of the species found at these localities; but that, up to the present time, these are all that have been identified or described. Future work will undoubtedly change the above figures.

Of the species found at the above localities, 50 are peculiar to one or another locality; 29 are found at two localities only, 14 at three localities, and 14 at four localities or more.

Taking the three typical localities, Martinez, Clayton and Tejon, 21 species are common to Martinez and Clayton, 30 to Martinez and Tejon, 25 to Clayton and Tejon, and 20 are found at all three localities.

As I have stated above, 16 species found in the upper member also extend into the older group, Division A. In addition to this, at the locality near Lower Lake Village, Lake county, besides several species encountered for the first time, I found 15 species in the same bed, within a superficial area of two feet. Of these, 3 were previously known to be common to the upper and lower division. Besides these 3, 7 of them were common to this locality, and localities of division B, and the remaining 5 were, before this discovery, considered peculiar to the lower member. One of these 5 is found in the Mississippi Valley, in the "Ripley Group," and another belongs to a peculiarly Cretaceous genus.

As to the species found at the several typical localities, independent of each other, and which would serve to show their individual relations to the older formation without corroborative evidence, Clayton has 10 species in common with Division A, Tejon has 7, and Martinez 11. With the Lower Lake bed, Clayton has 5 species in common, Tejon 5, and Martinez 6.

In glancing over Mr. Conrad's "check list" I find that out of the 107 species found in his "Older Eocene of California," he has only included 74 in his enumeration. He has omitted *Callianassa Stimpsonii*, Ammonites n. s., *Nautilus Texanus*, *Cylichna costata*, *Mactra Ashburnerii*, *Cucullæa Matthewsonii*, *Nucula truncata* and *Leda protexta;* eight species, which I mentioned in the Journal of Conchology (vol. ii, p. 88), as being found in common in the two members of the California Cretaceous, stating distinctly the localities in which they have been found. At the same time he includes five other species, from the same list, in his Eocene catalogue. Whether this be carelessness, or an unfair avoidance of a difficulty, I leave to others to decide. It is far easier to ignore such a difficulty than it is to explain it away.

In regard to the distribution of the genera and species in this and the associated rocks: all of the species are peculiar to this group, or to this and *underlying* rocks; *not one* has been found associated either with living forms, or with species known to occur in the recognized Tertiaries of California. Five of the genera are peculiar to the Secondary. An Ammonite ranges entirely through the group to the top of the highest fossiliferous strata. The genera *Perissolax*, *Gyrodes*, *Margaritella*, and the sub-genus *Anchura*, of the genus *Aporrhais*, are all recognized as strictly characteristic of the Cretaceous; so much so, that the presence of a single undoubted representative of either of these genera would be strong presumptive evidence of the Cretaceous age of any rocks in which it might be found. On the other hand, the presence of such genera as those in the list given below, would point to a very modern era in the Cretaceous, to say the least.

It must be borne in mind that we have much to learn yet in paleontology, especially in the matter of the vertical range of genera. Every year we find genera, nay, whole families, extending themselves beyond what had been fixed by previous authors as their limits. A few years ago, the presence of mammalian remains was considered characteristic of the Tertiaries. Now we know of Marsupials in the Trias, and who dare say that we may not find mammals in Paleozoic rocks? I therefore maintain, that though we have here such genera as Aturia, Typhis, Cordiera, Pseudoliva, Nassa, Mitra, Ficus, Morio, Cerithiopsis, Cypræa, and Galerus, still, the only inference that can be drawn is, that the group is on or near the verge of the formation, a sort of prophetic member, presaging by some of its genera the formations to come, but indissolubly bound by specific ties with the eras preceding.

ART. XXVI.—*On a new apparatus for technical analysis of Petroleum and kindred substances;* by S. F. PECKHAM.

IN the Chemical News for August 31st, 1866, I noticed a paper in which was described a process with apparatus, for the assay of coals and other substances yielding illuminating and paraffin oils.[*] After stating the fact, that no process had hitherto been described by which technical analyses of bituminous and pyro-bituminous substances could be made to yield analogous and satisfactory results, the author proceeds to describe what I should suppose to be a very valuable process for the primary distillation in the technical analysis of coals and shales. I do not repeat the description here, as it would require considerable space, and it can only be applied to the treatment of solid substances, which do not melt at a temperature below that required for their distillation. As the original paper is easy of access, I would recommend its perusal to all who wish to make technical analyses of either coals or shales. The apparatus is simple and inexpensive, and I am aware of no reason why the results furnished by it should not prove highly satisfactory, especially as its operation bears a striking resemblance to the most improved processes of manufacture on the large scale.

But beyond the primary distillation of the coal or shale, I do not consider that our author has added anything to processes long in use. When he arrives at the second distillation, or that which corresponds to the primary distillation of petroleum, he is forced to return to the old process of fractional distillation from a common tubulated glass retort. This process is not only very unsatisfactory in its results, but it is quite expensive, and is attended with considerable danger from fire. It is unsatisfactory, because the separation of fluids of different densities and different boiling points, is much less complete than by Warren's process, for any temperature below the boiling point of mercury; in fact, for any temperature necessary to ensure the complete separation of the light oils usually called naphtha, and the "photogen" or illuminating oil.[†] It is expensive, for the reason that if the distillation is conducted to dryness the retort is sacrificed, as it is rarely possible to remove the coke with safety. It is attended with danger from fire, because the best retorts are liable to fracture from the high heat to which they are exposed, even when the greatest care is exercised in conducting the operation.

[*] On the Assay of Coal, etc., for Crude Paraffin Oil, and of Crude Oil and Petroleum for Spirit, Photogens, Lubricating oil and Paraffin, by John Attfield, Ph.D., F.C.S., Director of the Laboratory of the Pharmaceutical Society of Great Britain. Chem. News, vol. xiv, p. 98.

[†] For details of this process, see Mem. American Academy, N. S., vol. ix, Chem. News, vol. xii, p. 85.

I was about to commence a technical examination of several specimens of California petroleum, when the above mentioned paper arrested my attention, and I was unpleasantly conscious when I had finished its perusal that in respect to apparatus for this department of research my want was just as far from being supplied as it was six years since, when I commenced the study of petroleums. I had but a small quantity of each specimen, and besides subjecting them simply to fractional distillation, I wished to test them by Young's process of distillation under pressure. To conduct the latter process in glass was an impossibility.

To answer my purpose therefore, my apparatus must fulfil the following conditions. It should be capable of working not more than one and one-half liters, and admit of being heated by an ordinary gas furnace. The joints should sustain a pressure of forty pounds per square inch, and it should be so constructed as to admit of the ready extraction of the coke. I could find no description of any such apparatus, but after numerous failures and corrections, in an apparatus of my own invention I found my want so well and fully supplied, that I am led to offer a description, for the benefit of those who, like myself, have felt the need of such an instrument.

Upon each extremity of a piece of a wrought iron gas-pipe, three inches in diameter and twenty inches in length, a cap is securely screwed. The caps should be heated nearly to redness and screwed on to the cold pipe in order that by their contraction they may be more firmly secured. The pipe is then put in a lathe and the caps turned off in such a manner as to leave a band upon each end of the pipe, about three-fourths of an inch in width, and two circular discs of iron, each about four inches in diameter, and one-fourth of an inch in thickness, having a projection upon one of their surfaces to which a wrench may be applied. The edges of each extremity of the pipe with the bands are now carefully turned off, presenting smooth surfaces slightly beveled inwardly. The plane surface of each of the discs is then so turned off upon its circumference, that it will exactly fit the beveled edge of the pipe. This completes the retort.

A stout parallelogram is then made half an inch longer and wider than the retort, one of the shorter sides of which should contain in the middle a stout set-screw, and the other an orifice made to fit the projection upon the disc. This may be called the frame.

Two holes are then drilled a short distance from either extremity of the retort, and in a line parallel to the axis of the retort. One of these should admit a half inch, and the other an inch gas-pipe. With this arrangement the retort may be used either for pressure distillation, or for distillation by the ordinary process. It also admits of being connected with an apparatus for furnishing superheated steam or carbonic acid gas, either of which are sometimes used to assist the distillation of hydrocarbons. Both the goose-neck and valve should be connected with the retort by a short piece of gas-pipe and a brass "union" or coupling, as the difference in the expansion of brass and iron would cause a joint of the two metals to leak very badly when subjected to a high temperature. The goose-neck may be made of the ordinary form, tapering from one inch to one-quarter inch, and about ten inches in length. The material should be copper, brazed. The valve will be described hereafter.

In order to use the retort, one of the discs is luted with a very thin paste of plaster of Paris and firmly pressed into its seat. The retort is then slipped into the frame and left a moment for the luting to set, the open end being uppermost. The oil is next poured in and the other disc luted into its seat, the frame adjusted and the set-screw firmly set up, so as to securely fasten both discs in their places. The goose-neck or valve is then adjusted, and the connections made with the worm and receiver. It will be observed that all the expansion that takes place in this retort only brings the different portions of the apparatus more firmly together, instead of causing them to crack apart and leak with every slight variation of temperature, as is usually the case. With this arrangement I was able to distill fifteen hundred cubic centimeters of petroleum to dryness, the last portions coming over at a red heat. The distillation was commenced with two ordinary Bunsen's gas lamps, increased as required to four, and toward the end of the operation to six—the latter number being sufficient to bring the side of the retort in contact with the flame to a bright cherry-red heat.

Any one who has attempted the distillation of small quantities of petroleum in either iron or copper stills, or retorts of whatever form, imbedded in coal fires or suspended over them, must be aware of the difficulty of so regulating the fire as to secure a constantly increasing heat from the beginning to the end of the operation. No such difficulty is experienced with this apparatus. In it the lightest oils may be distilled by means of a sand-bath, and the heaviest by applying the flame of a sufficient number of lamps directly to the retort. The joints of this apparatus when luted with the smallest possible quantity of finely pulverized calcined sulphate of lime, admit of the least loss by leakage of any metallic retort that I have ever used. With the exercise of proper care the amount of distillate from California petroleum averaged above ninety per cent by measure, and with a pressure of thirty pounds per square inch the average was eighty-seven and one-half per cent. In the latter instance the loss was increased by the formation of gas and vapors that passed through the worm uncondensed at 8° C. The largest amount of distillate that I have seen recorded, as yielded by any material of undoubted natural origin, is ninety-five and one-half per cent, by measure.* The distillation of which this was the product was performed wholly in glass, without pressure, the crude material being a California petroleum of medium density, yielding no permanent gases and no naphtha. In this case the loss may be estimated at zero. I think it will be readily conceded, that any apparatus which admits of the ready extraction of the coke, and at the same time yields an average of ninety-two and one-half per cent of distillate, furnishes results far more satisfactory than any hitherto in use for operating upon so small a quantity as fifteen hundred cubic centimeters.

A thermometer may be inserted in the smaller orifice, for noting the temperature at which light oils distill. A piece of gas-pipe of the requisite size and about two inches in length may be used for making the connection, the thermometer being luted into one end of it. When but one of the openings in the retort is in use, the other may be closed with an iron plug.

In making my experiments upon Young's process of distillation under pressure, I experienced much difficulty in contriving an apparatus that would enable me to register the amount of pressure, and at the same time prevent any loss of vapor. I first attempted to register the pressure by means of a U tube, the arms of which were of unequal length. The tube was filled with mercury to a level with the shorter arm and the long arm sealed with a column of air above the mercury. The pressure was indicated by the rise of mercury in the longer arm and consequent compression of the air, the shorter arm being in communication with the retort. The escape was badly regulated by an ordinary stop-cock. The very unequal expansion of glass and iron prevented me from making a tight joint between the retort and U tube.

I next tried a small valve constructed like an ordinary safety valve. I found it impossible with this valve to prevent a large amount of loss from escape of vapor around the spindle.

I next tried a loaded valve, the load of which was placed directly upon the spindle, the whole contained in a chamber resembling a miniature steam-chest, from which the vapors could only escape into the worm. It was found upon trial with the safety-valve that an orifice three-eighths of an inch in diameter was too large in proportion to the size of the retort, the vapors escaping in too large volume to admit of a continued flow from the worm. The vapor escaped in intermittent puffs, thereby causing an undulatory movement from the requisite amount of pressure to no pressure at all. As a consequence, the results

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* Report of C. M. Warren, Esq., contained in an article on Petroleum in California, by Prof. B. Silliman, National Intelligencer, Feb. 7th, 1866.

rendered were very imperfect. To obviate this difficulty, I made the orifice beneath the valve only one-sixteenth of an inch in diameter, the surface of the orifice being to that of the retort as one to sixty thousand. This arrangement enabled me to secure a constant flow of vapor from the retort, to maintain a constant pressure, and to preserve a constant degree of temperature. I found by computation that a pressure of two ounces avoirdupois upon an orifice one-sixteenth of an inch in diameter was equivalent to a pressure of forty pounds to the square inch, yet when I placed a weight of two ounces upon the spindle, which of itself weighed half an ounce, the steam gauge registered only ten pounds, and the oils passed through it unchanged in density. Although I employed one of the most skillful workers of brass in this city to grind the valve, I am satisfied that the fault was in the mechanical execution of the work, and that the bracing of the valve was upon the side of the cone instead of at its apex, leaving a minute cavity beneath the valve. This fault could only be remedied by increased pressure. The chamber being too small to admit of placing the requisite weight upon the spindle, I made use of a spiral spring, the force of which was adjusted by an ordinary steam-gauge. By this means I was enabled to obtain the required pressure and to estimate its amount, with but one source of error, viz., the diminution in the elasticity of the spring incident to the high temperature of the vapors of the oil. I am convinced that the amount of this diminution is considerable; I have estimated it at one-fourth. The original elasticity returns, however, as soon as the spring is cold.

The following is a description of the valve as finally arranged. A piece of wrought iron gas-pipe one inch in diameter and three inches in length is bored out true, and an orifice drilled in its side one and one-fourth inches from the upper end, into which is brazed a piece of quarter inch gas-pipe about three inches in length. Both ends are now turned off and threads cut upon them, to which are carefully fitted strong brass caps. The upper cap should be about three-quarters of an inch in thickness, perforated two-thirds through from the inside with an eighth-inch drill, the orifice to serve as a guide to the upper end of the spindle. There should be a nipple three-fourths of an inch in length upon the lower cap, to connect it with the retort. The cap should be about one-half an inch in thickness, and with the nipple, should be perforated with a sixteenth inch drill. The seat of the valve should be excavated in the inside of the lower cap. A diaphragm should be placed within the iron tube, one inch from its lower end to serve as a guide for the spindle, through the center of which the spindle should pass, while around it should be numerous small openings to allow for the free passage of the vapor. The valve itself should be turned upon the end of a spindle three-sixteenths of an inch in diameter, and carefully ground into its seat. The length of the spindle should be one-fourth of an inch less than the distance from the seat of the valve to the bottom of the orifice upon the inside of the upper cap, when both caps are in position. This allows the spindle to lift well, with sufficient room for the passage of the vapors. The diameter of the spindle should be reduced to one-eighth inch above the diaphragm. A spiral spring, of a diameter nearly equal to the interior of the pipe, made of brass wire about one-sixteenth of an inch in thickness, is so adjusted that the valve would be raised against the elastic force of the spring. This is effected by gradually reducing the diameter of the coils of the lower end of the spring to one-eighth inch, when it will just rest upon the shoulder upon the spindle. The upper coil of the spring should just touch the inside of the upper cap, when it is firmly screwed up. It will thus be seen that a force sufficient to cause the spring to contract one quarter of an inch is equal to a direct pressure upon the valve of two ounces. This pressure may be regulated by an ordinary steam gauge, the force depending for the same length of spring and size of wire upon the *number* of coils employed.

With this apparatus and the one described by Mr. Attfield, small quantities of every variety of bituminous and pyro-bituminous substance, may be subjected to treatment analogous to the most improved processes now in use upon the large scale. The results are reliable and admit of ready comparison. The cost of the retort with goose-neck and valve, made by the most skillful workmen, is about twenty-five dollars.

The annexed diagrams give a section of both the valve and retort.

Fig. 1 represents a horizontal section of the retort, one-fourth the size; in which *a a* is the gas-pipe; *b b* are the discs; *c c c c* are the bands left when the caps are turned off; *d d* is the frame and *e* the set-screw.

Fig. 2 represents a vertical section of the valve, of full size, in which *a* represents the upper cap, *b* the lower cap, *c c* the gas-pipe, *d* the escape pipe, *e* the spindle, *f f* openings in the same for passage of vapors, *g g g g* the diaphragm, and *h h h h* the spiral spring.

Providence, R. I., April 30th, 1866.

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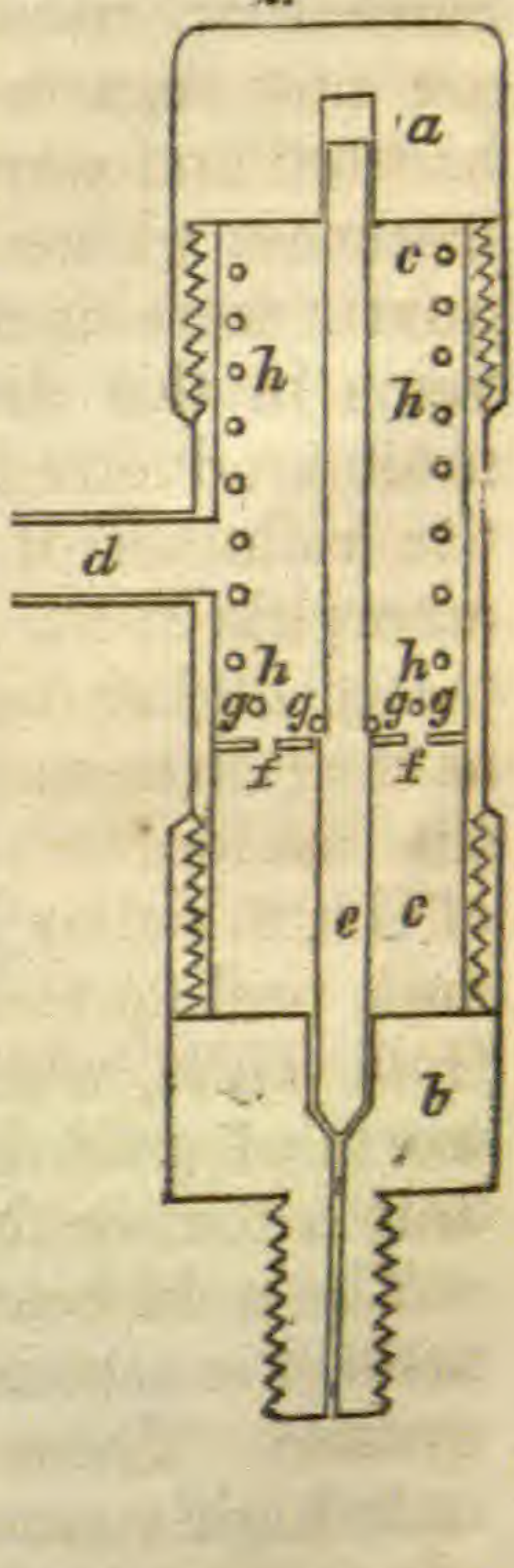

ART. XXVII.—*Notes on the Grass Valley Gold-mining District;* by Prof. B. SILLIMAN.

GRASS VALLEY DISTRICT has obtained a well-earned celebrity as the most prosperous of all the gold-quartz mining districts in California. Quartz mining was begun here as early as 1850, and has been continued with, on the whole, a steadily increasing success, to the present time.

It is difficult to obtain exact statistics of the total product of the Grass Valley quartz mines, but it is believed by those best able to form a trustworthy opinion on this subject, that the product in 1866 was probably not less than $2,000,000, while for the whole period from 1851—say fourteen years—it was probably in excess of $23,000,000.

Wm. Ashburner, Esq., in his remarks on the gold mining interests of California, in J. Ross Brown's Report on the Resources of the States and Territories west of the Rocky Mountains, speaks of the Grass Valley region (page 46) thus:

When we consider the richness of the veins, the length of time some of the mines have been worked, and the amount of gold annually produced, the most important quartz mining region of California is, without any doubt, that of Grass Valley, in Nevada county. Here mines have been worked uninterruptedly since 1851. It is true there have been periods when the interest was more than usually depressed, and several of the mines, which are now regarded as among the best, were thought to be exhausted and were abandoned for the time being, but in many instances where work was resumed new bodies of gold-bearing quartz were opened up, which proved rich and valuable. The veins in this district, and particularly those which have been most productive, are noted for their narrowness, as well as for the richness of the quartz. They are encased in a hard metamorphic rock, and the expenses of mining are, as a general thing, higher here than anywhere else in California, amounting as they do in some instances, to from $20 to $26 per ton. Within the last fourteen years the total production from the quartz mines of Grass Valley District has been not far from $23,000,000. The most prolific vein has been that situated upon Massachusetts and Gold Hills, which alone has produced more than $7,000,000 worth of gold during this time, from a lode which will average only a foot or fourteen inches in width.

The gold bearing rocks at this place are mostly highly metamorphic schists or sandstones passing into diorite or greenstone syenite. These greenstones seemingly crystalline, are probably only highly altered sedimentary rocks, containing a large amount of protoxyd of iron with sulphuret of iron. In some parts of the district, slaty rocks occur, more or less talcose or chloritic in character; masses of serpentine also abound, forming at times one wall of the quartz veins. This serpentine is probably metamorphic of the magnesian rocks last named. The red soil, seen almost everywhere in the Grass Valley district, has its origin in the peroxydation of the iron contained in the greenstones and diorites, and set at liberty by their decomposition.

The line of contact between the gold-bearing and metamorphic rocks of Grass Valley, and the granites of the Sierra Nevada is met on the road to the town of Nevada, about half a mile before coming to Deer creek. The talcose and chloritic slates are seen to the north, in the direction of the Peck lode, and in the slate districts of Deer creek.

The dip and strike of the rocks in the Grass Valley region is seen to vary greatly in different parts of the district. Following the course of Wolf creek, a tributary of Bear river, it will be observed that the valley of this stream—which is Grass Valley—as well as of its principal branches, follows in the main the line or strike of the rocks. In the absence of an accurate map of the region, it may not be easy to make this statement evident. But all who are familiar with the chief mines of this district, will recall the fact, that the course of the veins in the Forest Springs location, at the southern extremity of the district, is nearly north and south—N. about 20° E.—with a very flat dip to the east, while at the Eureka mine, on Eureka hill, about four miles to the northward, the course of the vein is nearly east and west with a dip to the south of about seventy-eight degrees. Again, commencing at North Gold Hill and following the course of the famous vein which bears the names of Gold Hill, Massachusetts Hill and New York Hill, we find the veins conforming essentially to the southerly course of the stream with an eastarly dip. The North Star, on Weimar Hill, has likewise the same general direction of dip. Near Miller's ravine, at El Dorado mill, Wolf creek makes a sudden bend to the left, or east, leaving the Lone Jack, Illinois, Wisconsin and Allison Ranch mines to the west. All these last named mines are found to possess a westerly dip, showing the existence of a synclinal axis running between the base of New York Hill and the mines having westerly dips last named, along which probably the veins will, if explored in depth, be found "in basin." The dip at Lone Jack is about 30° W., at Allison Ranch it is about 45° W. Just below the Allison Ranch mine, Wolf creek again makes a sharp turn to the left, nearly at a right angle, and then resumes its former course with the same abruptness. A mile lower down, where it strikes the Forest Springs locations, we find the Norambagua inclosed in syenitic rocks, dipping at a very low angle to the east, a dip seen also at still less angle in the Shamrock, yet farther south. There is probably a saddle or anticlinal axis below the Allison Ranch mine, due to the elevation of the syenitic mass, which, it seems probable, sets in at the sharp bend in the stream, before alluded to, and where the ravine trail joins it. The stream probably runs pretty nearly in the basin of the synclinal.

The rocks on the east side of Wolf creek, and above Forest Springs locations, dip westerly. Such is the case at Kate Hayes, and with the veins on Osborn Hill. The middle branch of the creek sweeps around to the east, forms its junction with the north fork, and the veins explored there near its upper waters, as at Union Hill, the Burdett ground, Murphy vein, Lucky and Cambridge, all dip southwest or south, conformably to the Idaho and Eureka, and at a pretty high angle. The Eureka vein going west, faults in the Whiting ground, and having previously become almost vertical has, west of the fault, a *northerly* dip at a high angle. At the Coe ground, this northerly dip is also found at an angle of about 50°. At Cincinnati Hill the vein dips southerly, in a direction exactly opposite to that of the North Star, there being a valley between the two, and a saddle or anticlinal between Cincinnati and Massachusetts Hills.

These facts, which, by a more detailed statement, could be easily multiplied, seem to warrant the conclusion that the course and dip of the Grass Valley vein is especially conformable to that of the rocks, and that the streams have, in general, excavated their valleys in a like conformable manner.

The quartz veins of Grass Valley District are not generally large. Two feet is probably a full average thickness, while some of the most productive, and those which have given, from the first, a high reputation to this region, have not averaged over a foot or possibly eighteen inches in thickness. There are some exceedingly rich veins which will hardly average four inches in thickness, and which have yet been worked at a profit, while at the same time there are veins like the Eureka which have averaged three feet in thickness, and the Union Hill vein over four feet. The Grass Valley veins are often, perhaps usually, imbedded in the inclosing rocks, with seldom a fluccan or clay selvage or parting, although this is sometimes found on one or both walls. The walls of the fissures and the contact faces of the veins are often seen to be beautifully polished and striated.

The veins are, as a rule, highly mineralized and crystalline, and afford the most unmistakable evidence of an origin from *solution* in water, and not the least evidence of an igneous origin. Chalcedonic cavities and agatized structure are very conspicuous features in many of the best characterized and most productive of the gold-bearing veins of this district. These indisputable evidences of an aqueous origin are seen in Massachusetts Hill, Ophir Hill, Allison Ranch, Kate Hayes and Eureka.

The metallic contents of Grass Valley veins vary extremely, some carry but very little or no visible gold or sulphurets, although the amount of gold is found in working in mill to be satisfactory, and the sulphurets appear on concentrating the sands from crushing. This is the case in the Lucky and Cambridge mines, for example. But in most cases, the veins of this district abound in sulphurets, chiefly of iron, copper and lead, the sulphuretted contents varying greatly in the same vein; zinc and arsenic are found also, but more rarely. The most noted example of arsenical sulphurets are in the Norambagua and on Heuston Hill; lead abounds in the Union Hill lodes (as galena,) and the same metal is found associated with the yellow copper in parts of the Eureka mine. The gold when visible is very commonly seen to be associated with the sulphurets—this was particularly the case in Massachusetts Hill; while in Rocky Bar and Scadden Flat, on the same vein, the gold is found sometimes in beautiful crystallized masses, binding together the quartz and almost destitute of sulphurets. Mr. William Watt informs me that in working some seventy thousand tons of rock from Massachusetts Hill vein, the average yield of gold was about $80; but at times this vein was almost barren, while again the gold was found in it so abundantly, especially where it was thin, that it had to be cut out with chisels. It is matter of notoriety that in the Gold Hill vein (continuation of the vein in Massachusetts Hill) portions of the lode were so highly charged with gold that the amount sequestered by the miners in a single year exceeded $50,000. On the other hand, in the Cambridge and Lucky mines, yielding about $35 to $60 of gold to the ton, the precious metal is seldom visible. In the Eureka, where the average yield of gold in 1866 was $50 per ton, it seldom exhibited what may be called a "specimen" of gold.

The structure of the veins in Grass Valley varies, in different portions of the district, especially in respect to the distribution of the pyrites and of portions of the adjacent walls. On Eureka Hill, the veins possess a laminated structure parallel to the walls, enclosing portions of the diorite or talcose rocks, forming closures or joints in which the vein splits easily. On these surfaces of cleavage minute scales of gold may often be detected by close inspection. The sulphurets are also seen to be arranged in bands or lines parallel to the walls. In many other cases, this kind of structure is found to be wholly absent, while the sulphurets and gold appear to follow no regular mode of distribution. In a few mines the sulphurets are arranged very distinctly in bands of zones, parallel to the walls, forming "ribbon quartz." This is especially distinct in the Norambagua, where, as before mentioned, the sulphurets are arsenical, and the gold very finely disseminated.

The average amount of gold in the Grass Valley veins is believed to be considerably in excess of what is found in most other portions of California. In Allison Ranch, Massachusetts Hill, Rocky Bar, Ophir Hill, and Eureka, this average has probably reached $50 to the ton. In many other mines it has been considerably less, but on the whole, $30 may not be far from the general average for the whole district; meaning of course, the amount actually saved by milling operations.

The loss of gold is very various, but is probably nearly always greater than owners are willing to confess—if indeed they know, which is doubtful. It is certain, in one well known mine, my own samples of quartz sands, and sulphurets from "pans," assayed respectively $23 and $57 per ton—a result which was later confirmed, quite independently, by the researches of a very competent mining engineer. In other cases, as at Eureka and Norambagua, my own researches show the loss in the tailings to be very small, not exceeding seven dollars to the ton in the latter, and less than that in the former.

The gold in many of the Grass Valley mines is very easily worked, being clean, angular and not very small, hence it is readily entangled in the fiber of blankets, together with a considerable portion of sulphurets, naturally leading to the method most commonly in use in Grass Valley for treatment of the gold ores.

What may properly be called the Grass Valley method of amalgamation consists in the use of heavy stamps, seven hundred or a thousand pounds, crushing usually two tons, sometimes two and a half tons of ore each in twenty-four hours—through screens not exceeding No. 6, rarely so fine. Amalgamating in battery and copper aprons are usually omitted. In some mills, murcurial riffles are placed in front of the discharge, but commonly the whole body of crushed stuff is led at once over blankets, which are washed out every few minutes into tanks where the free gold and sulphurets are allowed to collect preparatory to being passed through the "Attwood amalgamators." These simple machines are designed to bring the gold into thorough contact with mercury contained in little vats sunk in the surface of an inclined table, over which the stuff is fed to the vats in a regulated manner by a stream of water, while iron blades slowly revolve in the vats to cause a mixture of the sands and quicksilver. By this apparatus, at the Eureka mill ninety per cent of all the gold is obtained which is saved from the ore. Beyond the amalgamators, the sands are carried over amalgamated copper sluices, and are put through various ore-saving processes with a view especially to concentrating the sulphurets. These processes vary much in different mines. In some mills, especially the Ophir, much more elaborate mechanical apparatus has lately been introduced—with what results still remains to be seen. It is certain that if the method of treatment just sketched seems imperfect, (as it undoubtedly is,) it is the method which has hitherto yielded the large returns of gold for which Grass Valley has obtained its well-deserved renown. As the development of the district goes forward, cases will occur of veins containing gold in a state of very fine division, to which other methods of treatment must be applied. Such examples indeed already exist, and the problems which they offer will be met by the use of other systems of amalgamation, or by suitable modifications of the existing system.

The sulphurets occurring in the Grass Valley District are usually rich in gold—some of them remarkably so. In quantity they probably do not on an average amount to over one per cent of the mass of the ores, although in certain mines they are found more abundantly. For a long time there was no better mode known of treating them than the wasteful one of grinding them in pans and amalgamating. In this way rarely was 60 per cent of the gold saved. After many abortive efforts, at length complete success has been met with in the use of Plattner's chlorination process. Mr. Deetken, now connected with the reduction works of the Eureka mine, is entitled to the credit of having overcome the difficulties which formerly prevented the successful use of this process in Grass Valley, a more detailed description of which will be found in our notice of the Eureka mine.

Of the length of the productive portion of quartz veins and the depth at which they commence to become productive, Grass Valley offers some instructive examples.

The North Star vein, on Weimer Hill, has been proved productive on a stretch of about one thousand feet, while the proportion of gold has gradually increased with the depth, from an average of twenty dollars in the upper levels to nearly double that in the lower levels. The limits named are rather those of exploration than the known extent of the productive ore. In the vein on Massachusetts and Gold Hills, on the contrary, the distribution of the "pay" has been found much more capricious, being at times extremely rich, and again with no apparent reason yielding scarcely the cost of milling. The Eureka mine offers the most remarkable example, however, of a steady increase from a non-paying amount of gold near the outcrop to one of uncommon productiveness. An opinion has found advocates, and has been perhaps generally accepted by most writers on the subject of gold-bearing quartz veins, that they were richest near the surface and in depth became gradually poorer. There is nothing in the nature of the case, as it seems to me, to justify such a generalization, more than there is to sustain an opposite opinion. If we accept facts as a guide, we find in California that the deepest mines, for example, Hayward's Eureka, in Amador, 1,200 feet, North Star, 750 feet on the slope, Princeton, in Mariposa county, 800 feet, Eureka (Grass Valley) 400 feet, Allison Ranch, 525 feet, etc., as a rule have an increasing amount of gold. If the Allison Ranch, the Princeton mine, and some others appear to be exceptions, the answer is, we may reasonably expect the same variations of productiveness in depth which are known to exist in linear extent. The Princeton, after an excellent run of good ore, became suddenly poor, at a depth of over six hundred feet, in 1865; but I am informed by Mr. Hall, the present superintendent, that the good ore came in again in a short distance. Mr. Laur, the French engineer, whose papers on California mines is often quoted, cites the Allison Ranch mine in evidence of the theory of a decreasing amount of gold in depth, but it is in proof that since the date of Mr. Laur's visit (1862-3), this mine has been at work on ores which have yielded over one hundred dollars value, its present suspended activity being due to causes quite unconnected with the intrinsic value of the mine. The rich "chimneys," or productive zones of ore ground, are known to be of various extent in quartz veins, from a few feet to many hundreds of feet, and it is impossible to assign any valid reason why we may not expect the same changes in a vertical direction which we find in a horizontal. As the ore-bearing ground or shoots of ore have in many, if not in most cases, a well determined pitch of the vertical, it is self-evident that a vertical shaft, or incline at right angles to the vein must, in descending, pass out of the rich into poor ground, at certain intervals, and it is perhaps due to ignorance of this fact that miners have abandoned sinking because they found the "pay" suddenly cease in depth, when a short distance more would probably bring them into another zone of good ore. The experience of every gold mining district offers examples in illustration of these remarks. In quartz veins containing a considerable amount of sulphurets, it is evident that the outcroppings should offer much better returns to mining industry than will follow after the line of atmospheric decomposition has been passed, because above this line nature has set free the gold formerly entangled in the sulphurets, leaving it available for the common modes of treatment, with the added advantage often times that the particles of free gold formerly distributed through a considerable section of the vein, are found concentrated in a limited amount of ore. It is easy to reach the conclusion in such cases, that the amount of gold in the vein is less in depth, after the real average amount is reached, while in fact it is neither greater nor less; but the metal is no longer available by common methods of treatment.

The Eureka mine.—From the date of its location, February 7, 1857, to the close of 1858, the mine proved only a source of expense to its owners, and its history is instructive as suggesting that shallow surface explorations, in gold mining, may be as unsatisfactory as they are known to be in other mining enterprises. So late as 1858, it is said, that five thousand tons of quartz taken above the drain level, or thirty feet from the surface, yielded in mill less than ten dollars per ton in gold, not returning expenses. A shaft sunk to a depth of about fifty feet afforded quartz, however, which yielded about fifteen dollars per ton, and the amount of gold rapidly increased to twenty-eight dollars at one hundred feet. Between the one hundred and two hundred feet levels the average yield was about thirty-seven dollars per ton, and between the two hundred and three hundred feet levels the average has been about fifty dollars per ton, rising to sixty-four dollars in the last four months of 1866.

There are in fact two distinct veins in the Eureka mine, separated from each other by a mass of greenstone or metamorphic sandstone, about twenty-eight or thirty feet in thickness. The smaller of these veins is on the south and has not been explored, but is a well-defined vein at the points where the shaft and cross cuts have exposed it. The greenstone forms the hanging wall of the main vein, and is particularly regular and smooth, in some places beautifully polished. The foot wall consists in some parts of soft serpentine, and when the vein pinches it appears to be from swelling of the foot wall. No other mine in this region has such a structure as the Eureka, so far as I know, and there is very much in the peculiarities here described to favor the highest confidence in the permanence of this great ore channel, both in depth and extent.

It is interesting to analyze a little more in detail the returns of this mine, as illustrating a point already alluded to, viz—its progressive increase of gold with an increase of depth.

From October, 1865, to December 31, 1865, the quantity of quartz crushed was twenty-four hundred and forty-five tons, yielding an average of $33.87 per ton, and costing to mine and reduce $13.51.

From January 1st to June 1st, 1866, the crushing was forty-seven hundred and three tons, averaging $42.68 per ton, at a cost of $12.52 per ton.

From June 1st to September 30, 1866, the amount of quartz crushed was forty-two hundred twenty-seven and three-fourths tons, giving an average yield of $60.33 per ton, at a cost of $15.78 per ton.

For the whole year ending September 30, 1866, the total crushing was eleven thousand three hundred and seventy-five and three-fourths tons, yielding a general average per ton of $47.15, at a mean cost per ton of $13.75.

The net profits for the year ending September 30, 1866, were $368,042.18. The ratio of costs of mining to the gross product was, for the three periods named above, respectively, 40½. 29½ and 26½ per centum. In the mining costs are included all charges for dead work, machinery, etc. The profits of the Eureka mine have, therefore, for the period named, averaged in round numbers from sixty to seventy-four per cent of the gross product of the mine. The earnings are divided every twenty-eight days, making thirteen annual dividends.

The bullion of the Eureka mine is about 850-thousandths fine, worth $17.57 per ounce. This value is, of course, slightly variable, say within five-thousandths.

ART. XXVIII.—*The Action of Sunlight on Glass;* by THOMAS GAFFIELD.

THE great attention now given to all the phenomena connected with light and heat may awaken some interest in the experiments in which I have been engaged for the past four years on the subject named at the head of this article. Perhaps I cannot better commence my essay, than by quoting from the "Proceedings of the Natural History Society," (vol. ix, p. 347) an account given before that Society, of my experiments in 1863, and after I had been engaged in them only a few months.

"He believed that his experiments in connection with the subject were original as to their method and their extent, although it had long been observed in Europe that colorless or light-colored plate-glass had turned to a purple hue by exposure to intense sunlight. One case* is cited of a change to a gold color; and one experiment recorded by Dr. Faraday,† some forty years ago, proving that a light purple changed to a darker hue after eight month's exposure.

"Other experiments are on record showing the action of glass of different colors as media in the transmission of light and of heat; but none, with the above exception, showing the effect produced on the glass itself.

"An experience of some twenty years in the window-glass business had only presented a few isolated cases of supposed change of color from this cause, which were attributed to some obvious defect in an article of inferior manufacture; but, within

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* Journal of Society of Arts for Feb. 15, 1854.

† Dr. Faraday's Chemical Researches. London, 1859, p. 142.

a short time, he had heard of the change of color in an article of superior manufacture, in a quantity of white plate glass, of which some lights had been broken out of a window in which they had been exposed to the sun.

"This fact coming to his knowledge led him to try an experiment with several specimens of plate, crown, and sheet glass, during the month of July last; which proved that a month's exposure to a hot sun would change the best white French plate and all white sheet glass, such as is used for photographs and engravings, to a color containing more or less of a yellow hue. The dark green and dark blue or bluish green did not experience any change; but any hue which approached a white, whether bluish, greenish, or yellowish white, turned to a yellowish color.

A second series of experiments, commenced in July, and continued three months, on some thirty specimens from France, England, Belgium, Germany, and the United States, only confirmed the results of the first; and a daily examination at first, and afterward from week to week, and month to month, revealed the interesting fact, that, even after a single day's exposure to a July sun, the change of color will, in some instances of the lightest hues, commence.

"So remarkable was the change in a week, affecting nearly all the light-colored glasses, that he commenced a third experiment on the 6th of August which should speak for itself. He then exhibited to the Society ten pieces of French white plate-glass, four by two inches in size (all of which were cut from the same sheet), one of which showed the original colorless glass, and the others exhibiting the change of hue towards yellow, after exposure respectively of one, two, and four days; one, two, and three weeks; one, two, and three months.

"The changes in the first four days were slight; but the last specimens were so yellow as to exhibit a contrast very marked, and excited the interest of all the members present. That the color permeates the body of the glass, and is not confined to the surface, or produced by reflection therefrom, has been conclusively proved by grinding off about one-sixteenth of an inch from both surfaces and the four edges of a duplicate exposed specimen, which, after repolishing, still exhibited the same yellow color.

"The glasses exposed were all what are called colorless window-glasses, although they varied in tinge and hue from the whitest French plate to the darkest green English sheet-glass.

"An experiment for four months, from July to November, on really *colored* glasses, red, green, yellow, blue, and purple, showed no change except in the purple, which became slightly darker.

"The experiments were carried on upon a rough plate-glass roof, nearly horizontal, and which received the rays of the sun during the greater part of the day. In all cases, strips corresponding to those exposed, and cut off from the same pieces, were placed in the dark, to be compared with the other specimens after exposure.

"It will be noticed that the dark green, blue, and bluish green did not change. The color of the Belgian sheet (called German or French by glass-dealers in America), a yellowish or brownish green, did not change; and these were the only exceptions. All plate-glasses changed, except an inferior blue quality, and a superior crystal plate of a greenish color, made in Germany, and at the only factory which has not given up the use of potash for soda-ash.

"It is possible that a longer exposure of a year, or of years, might change every color in some degree.

"His inquiries, since he instituted these experiments, have brought out some fine specimens of Belgian sheet-glass from a house built three years ago, which had changed in some instances to a golden and in others to the well-known purple hue.

"It is his intention to pursue the experiments farther, with a view to ascertain the effects of sunlight during each month and season of the year; and also whether exposure to heat, air, or moisture alone, out of the direct action of the sun's rays, will produce any corresponding change.

"Mr. Gaffield does not propound any theory to explain these changes of color, which, under our sunny skies, probably take place much more rapidly than in the different and less clear atmosphere of England.

"Some writers point to the presence of oxyd of manganese in the original composition of window-glass, and some to the oxyd of iron, as a chief cause.

"Some writers have peculiar theories about the different classes of the sun's rays. Some may think the change referred to, a molecular or chemical one; and others, wiser than the rest, refrain from any explanation, waiting for a larger multiplication of experiments, and a greater accumulation of facts, before educing any satisfactory law of nature which governs these curious and interesting phenomena.

"Mr. G. makes no pretentions to any discoveries, unless it be to the very rapid change in glass observed in our climate in July, but only gives the result of his experiments, in the hope that the great interest now manifested in the subjects of light and heat may lead others to examine the matter, to repeat the same experiments in other countries, and to give the world the result of their researches, and enable the learned and scientific men of the age to explain this remarkable power and action of the sun's rays.

"It should be remembered that he submitted his specimens to the most severe tests by placing them where they received reflected as well as transmitted light and heat. The change in glass, when glazed in the windows of our dwellings and stores, is so much more gradual, that it very rarely attracts the attention of observers, except in the marked variation from white to purple."

In accordance with the intention above expressed, I have continued my experiments on this interesting subject, and under different heads will now give some account of their method and results.

My first experiment was with pieces of glass four by six inches, placed in a sash six by sixty inches long, in the grooves of which the specimens were placed, the sash being fastened together by wooden pins, and placed on a nearly horizontal rough plate-glass roof, which received the direct rays of the sun during the greater part of the day. In my next experiment, I placed some of the specimens directly on the rough plate-glass. These were carried on in summer and autumn. It was necessary to make a different arrangement for winter, when the fall of snow and the formation of ice might interfere with the full success of the experiments. I concluded that the best size for specimens was four by two inches, and I made some wooden boxes about ⅝ inches deep, 4¼ inches wide, and of a length to fit the sills of windows facing the south, in the upper story of a Boston house. One of the windows was three-sided, looking east, south, and west. In these boxes, painted white, my specimens were placed in a nearly horizontal position, side by side, and, (after the loss of a few pieces, blown away by hurricanes and squalls), were secured in their positions by cords of twine or slight copper wire fastened at each end. I have arranged boxes on the roof in front of this window also, some being of greater depth in which to place pieces of plate and rough plate about one inch in thickness. All of these boxes are provided with covers, which are placed over the glass, and fastened by buttons, on the occurrence at any time of a snow storm. At all other times, the glass is exposed. Holes in proper places in the boxes allow the rain which falls to pass off easily. Every piece of glass is carefully marked by a diamond in an upper corner with its name, and if necessary, with some abbreviation descriptive of the experiment to which it belongs. This precaution is necessary to prevent mistakes, when a comparison is to be made of several kinds and colors, of exposed and unexposed specimens. In all cases, where an experiment is to be made with any description of glass, the pieces (4×2 inches in size) must all be cut from the same sheet, as there is frequently a slight difference in the shade of sheets from the same factory, arising from the difficulty of having the materials in their manufacture, and the circumstances attending the melting, blowing or casting precisely the same. Two pieces or more should be laid aside to show the original color, and to compare with the others, and thus to show the changes produced by exposure to sunlight for days, weeks, months or years. At the commencement of an experiment, say for instance, the exposure of white plate-glass for from one to twelve months, a neat paper box is provided, 4¼ inches long, 2⅛ inches deep and wide enough to hold fourteen pieces, (two of the original color, and twelve exposed specimens) and a description of the contents is marked on its cover on an adhesive label. At the end of each month, a piece is withdrawn from exposure, carefully cleaned, and marked either with a diamond or by an adhesive label, and placed in the box. As "order is heaven's first law," it is peculiarly necessary in all observations upon the actions of heaven's brightest luminary. By observing the above directions, much time will be saved, and at the conclusion of an experiment, everything is in shape for exhibition to friends at home, or students at a lecture room.

Of course a *perfect* arrangement could only be made when a perfectly flat roof or platform in an open field could be provided, and the sunlight could act with full force during every hour and minute of the day. But mine was sufficiently near this point to show very interesting results.

In one of my earliest experiments, I kept a record of the changes going on in the various kinds of glass, at first from day to day, and afterwards from week to week, and month to month. The following is a specimen:

Kinds of glass.	Original color before exposure.	Color after one day's exposure.	Here were inserted other columns to show effect of exposure for 2 and 4 days, for 1, 2 and 3 weeks, for 1 and 2 months.	Color at end of exp't. (3 mos.)
French white plate,				
English crown glass.				
French white sheet.				
Belgian sheet.				
American sheet.				

I might give the names of all the different kinds of glass which I have exposed to sunlight, but I refrain because for the reason given previously, I have found different specimens from the same manufactory of plate, of crown, and of sheet-glass, sometimes to differ in shade, sometimes in result of exposure, and sometimes in both.

I will, however, give below, (not naming the particular manufactories), a general description of my experiments in 1863, when an exposure of thirty-three specimens for a few months in summer and autumn showed the following results.

The first table shows that twenty-four kinds were found to be easily affected, and exhibits the time at which the change in color was first observed. The second table shows nine kinds which did not change in color during the same time.

Table of glasses easily changed.

Kinds of Glass.	Original color before exposure.
5 of French white plate.	White, with light bluish green tinge.
2 " German " "	White " " " " "
1 " English white plate.	White " " " " "
5 " " plate.	Yellowish green.
1 " Belgian rough plate.	White, with slight green tinge.
3 " French white sheet.	" with light bluish green tinge.
1 " Belgian " "	" " " yellowish green tinge.
4 " English " "	One light yellowish green and three light bluish green tinge.
2 " American " "	White, with light blue green tinge.
24	

The time at which change of color was first observed.									Color after exposure.
Days.			Weeks.			Months.			
1	2	4	1	2	3	1	2	3	
1		4							Yellow or yellowish green.
1				1					" "
1									" "
	4			1					Deeper yellow tinge.
		1							Yellowish green tinge.
3									" "
1									" "
	1		1	1		1			" "
1		1							" "
8	5	6	1	3		1			

Table of Glasses not changed in three months.

Kinds of glass.	Original color of glass.
1 kind of German crystal plate.	Light green.
1 " " " plate.	Dark blue.
1 " " English rough plate.	Dark green.
1 " " English crown.	Light green.
1 " " American "	Bluish green.
1 " " " sheet.	Dark bluish green.
1 " " English "	Dark green.
1 " " Belgian "	Yellowish or brownish green.
1 " " French "	" " " "
9	

Subsequent experiments with five of these kinds, (all which I could conveniently obtain), showed that an exposure of a year, or even less, would change all but an ordinary kind of American sheet, which was of a dark bluish green color.

The experiments which speak for themselves are the most satisfactory ones, that is to say, where one has not only the record made at the end of each month, but a piece of glass taken in and laid aside at the same time to show the actual color produced, and the truth of the records. It is very interesting to witness any one of these series of specimens, showing, as in one of white plate, a gradual change, commencing in a day or a few days in summer, from greenish or bluish white to a yellowish white, or light yellow, a deep and deeper yellow, until it becomes a dark yellow or a gold color; and in some Belgian sheet specimens, a gradual change, commencing in a few weeks in summer, from brownish yellow to deeper yellow, yellowish pink, pink, dark pink, purple and deep purple.

There are several kinds of glass in which no perceptible change took place in three months, which were very sensibly affected by an exposure of a year.

Experiments.—I have given a general account of my first experiments in 1863, and a portion of the tables kept in my journal at that time. I might have given names and results in full and shown the actual effects and shades of color produced by exposure for a few months, on some thirty kinds of glass. But in my case, as in many novel and original investigations, the results of first experiments, and the theories based upon them, were modified by subsequent ones. I supposed that many kinds of glass not changed in three months would not change at all: that all which changed would take a yellowish color, unless by exposure of many years: that no color but some shade of yellow or pink would ever be produced in any kind by exposure to sunlight.

The experiments of 1864 and the two following years, proved to me that nearly every kind of window glass I had exposed, could be changed in one year; that a rose or pink color, (or some tint approaching them) could be produced in various kinds in a few months; and that some kinds of greenish white glass would, after exposure, assume a bluish tint or bluish white.

It may seem singular for one who has been a glass dealer and manufacturer like ourselves, thus to advertise what may be called a defect in his own wares. It might seem unkind to other manufacturers to expose the defects of their productions, literally before the light of day. But my scruples have been all removed, when I have noticed in a late communication of Pelouze (see Comptes Rendus, Jan. 14, 1867) the following statement: "I do not believe that there exists in commerce a single species of glass that does not change its shade in the sunlight." As all manufacturers are in the same category, it will do no harm for me to repeat what Pelouze says, as the result of my experiments, and to affirm that a longer or shorter exposure to the direct action of the sun's rays will probably change in some degree the color of all or nearly all kinds of window glass.

I subjoin an account of an experiment carried on for one year with nine different kinds of glasses. These represent plate, crown and cylinder glass, the manufactures of both hemispheres and almost every shade and color of what are called colorless glasses.

I name only the nationalities, and not the particular manufactories of the glasses in any of my tables. I have this information recorded in my journal, and shall be happy to communicate it to any who may desire it.

Memorandum of nine different kinds of glass exposed from Jan. 12, 1866, *to Jan.* 12, 1867.

Kind of glass.	Color before exposure.	Color after exposure.
French white plate.	Bluish white.	Yellowish color.
German crystal plate.	Light green.	Bluish tinge.
English plate.	" "	Yellowish green.
English crown.	" "	Light purplish color.
Belgian sheet.	Brownish yellow.	Deep " "
English sheet.	Dark green.	Brownish green.
American crystal sheet.	Light bluish white.	Purplish white.
" " "	Lighter bluish white.	Light yellowish green.
" ordinary "	Bluish green.	No change.

The colors named above are given from an observation of the glass edgewise, by which one can see a body of color two or four inches in depth, whereas the usual thickness of the glass varies from one-fourteenth to one-quarter of an inch, and shows its color easily only by placing a white curtain or paper behind it.

I have tried several experiments showing the effect of sunlight during each month and each season of the year. At the end of the year, by the comparative depth of yellow or purple color produced in the various specimens, one can see the comparative actinic power of the rays during each month and season. The results proved that the actinic effect increased from January to July, and decreased after that month. The greatest effect during any season was observed in the summer, the least in winter, and that in spring and autumn was about alike, and midway between that of summer and winter.

Crystal or lead glass, and a piece of optical glass having probably very little, if any, manganese, changed not in two years. Perhaps a longer exposure may produce some change.

A rough piece of light colored window glass metal changed to a yellowish color in a year.

Colored glasses after two or three years' exposure showed no perceptible change in any instance except a slight one in a single specimen of purple. Perhaps an exposure of many years may make a change in some other colors.

I have made experiments with artificial heat on glass in various ways, from exposure to the heat of a cooking range oven to that of a glass stainer's kiln, without any change of color in the common colorless window glasses, while the same or similar specimens exposed to sunlight have been nearly all changed in a few months.

Specimens exposed in hot water for a month, in doors and out of sunlight, experienced no change of color, while similar ones exposed during the same length of time in the bottom of a dish filled with two or three inches of water out of doors, and to the direct rays of the sun, experienced a decided change, though only about half as much as when directly exposed, out of the water.

Being convinced that air, moisture, and artificial heat do not make any change of color, our experiments indicate that the change is effected by the actinic rays of the sun alone.

This actinic effect is cut off in some degree by every medium, by water as stated above, and even by clear glass, as a specimen exposed inside of a window or under another piece of thin colorless glass shows only about one-half as much change, as that exposed outside of the window or with no covering of glass over it. The amount cut off by colorless glass and by colored glass differs greatly with the difference of color.

[To be concluded.]

ART. XXIX.—*Crystallogenic and Crystallographic Contributions;* by JAMES D. DANA.—No. IV. *On a connection between Crystalline form and Chemical constitution, with some inferences therefrom.—Supplement.*

I RETURN to the subject of my article published in the last number of this Journal in order to present a few additional remarks with regard to the bearings of the views on chemical science.

7. *Chemical formulas of the Silicates.*—In the attempts to write the formulas of the Silicates on the new system there has been a difficulty, as the results have shown, in arriving at similar formulas for related species. Part of the diversity in the formulas presented have arisen from the unsettled views among chemists themselves; but another part from the fact that the species vary widely through isomorphous substitutions, and especially through the occurrence, in the basic part, of the elements in different states of oxydation. The method of designating the elements as they exist in these several states by prefixing a Greek letter to the symbol, proposed in my former communication,[*] affords a convenient means of attaining all the uniformity and simplicity in the formulas that can be desired.

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[*] This volume, page 89.

It will be remembered that the states of R in the oxyds RO, R^2O^3, RO^2, RO^3, RO^5 (which are equivalent to RO, $3(R_{\frac{2}{3}}O)$, $2(R_{\frac{1}{2}}O)$, $3(R_{\frac{1}{3}}O)$, $5(R_{\frac{1}{5}}O)$), or in RS, R^2S^3, RS^2, etc., were made, respectively, the αR, βR, γR, δR, ϵR states, these symbols standing severally for R, $R_{\frac{2}{3}}$, $R_{\frac{1}{2}}$, $R_{\frac{1}{3}}$, $R_{\frac{1}{5}}$ in the above.

The larger part of the silicates are included in two divisions: the *Unisilicate*, and the *Bisilicate*,* as recognized in the edition of my Mineralogy of 1854. The Unisilicates have, on the old system, the general formula $\dot{R}^2\ddot{Si}$, when only protoxyds are present, and $(\dot{R}^3, \bar{R})^2\ddot{Si}^3$, when part of the base is sesquioxyd, $\dot{R}^3$ and $\bar{R}$ being mutually replaceable in different proportions. The Bisilicates have the corresponding formulas $\dot{R}\ddot{Si}$ and $(\dot{R}^3, \bar{R})\ddot{Si}^3$. With $\dddot{Si}$, the formulas are $\dot{R}^3\dddot{Si}$, $(\dot{R}^3, \bar{R})\dddot{Si}$; and $\dot{R}^3\dddot{Si}^2$, $(\dot{R}^3, \bar{R})\dddot{Si}^2$.

In writing these formulas on the new system, and adopting the system of symbols for the metal of the corresponding oxyds, αR, βR, etc. (but dropping the α as unnecessary), the formulas above cited become

for the ordinary Unisilicates (1) $\left.\begin{matrix}\text{Si}\\ \text{R}_2\end{matrix}\right\}\text{O}_4$ (2) $\left.\begin{matrix}\text{Si}\\ (\text{R}, \beta\text{R})_2\end{matrix}\right\}\text{O}_4$

for the ordinary Bisilicates (1) $\left.\begin{matrix}\text{SiO}\\ \text{R}\end{matrix}\right\}\text{O}_2$ (2) $\left.\begin{matrix}\text{SiO}\\ (\text{R}, \beta\text{R})\end{matrix}\right\}\text{O}_2$

The silicates of each division, whether containing sesquioxyds, or protoxyds, or both, have on this method essentially the same formulas. Moreover the other states of oxydation may be introduced with the same facility, and thus the remainder of the Unisilicates and Bisilicates be included. We thus bring under two expressions

Unisilicate, $\left.\begin{matrix}\text{Si}\\ (\text{R}_2, \text{R}, \beta\text{R}, \gamma\text{R}, \delta\text{R})_2\end{matrix}\right\}\text{O}_4$, Bisilicate, $\left.\begin{matrix}\text{SiO}\\ (\text{R}_2, \text{R}, \beta\text{R}, \gamma\text{R}, \delta\text{R})\end{matrix}\right\}\text{O}_2$

much the larger part of the silicates, and exhibit to the eye the fact of unity among them, and the truth also that in inorganic nature the types of compounds are few and of the simplest kind. By means of fractional coëfficients the atomic ratios between the R, βR, etc., are easily indicated.

By way of illustration I give below the special formulas of various mineral species under these general formulas, together with those also of the *Subsilicates.* The list is made longer than

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* I use these terms in place of *Orthosilicates* and *Metasilicates*, because they express a definite fundamental fact under both the old and new systems of chemistry. In the *Unisilicates*, viewing them with reference to the new system, the two classes of elements combined with the oxygen, that is, the silicon, and R (or the basic metals), have between their *combining powers* the ratio 1 : 1; silicon, a *tetrad*, being associated with *two* basic *dyads*, or their equivalent; while in the *Bisilicates*, this ratio is 2 : 1, silicon being associated with *one* basic dyad or an equivalent. By employing the Latin numerals to express this relation as to combining powers, there is no conflicting with the numerals which are now in use, and which express the ratio between the elements themselves, the latter being all in Greek. Moreover the prefix *meta* in the term *metasilicate* has a diversity of significations in the new chemistry, while etymologically hardly any significancy whatever.

would be necessary for a simple exemplification of the principle, in order to show the efficiency and wide application of the method proposed, and the close parallelisms which it exhibits in the formulas; and also because the subject of the formulas and true relations of the silicates is now attracting much attention.

The formulas beyond are written in a little different manner from what is usual, partly for the sake of compactness on the page, but more because I regard the position of the connecting O *between* the other two members of these ternaries as preferable to that ordinarily given, and better adapted to exhibit on the page the serial analogies and differences of the compounds.

If there are those who would prefer to see the ratios expressed in whole numbers instead of fractions, such can easily gratify themselves in this respect by performing the requisite multiplications. But when this work is done, the result is very far from complete; for in many species, as garnet, epidote, idocrase, pyroxene, hornblende, etc., R corresponds to a number of different elements, as Ca, Mg, Fe, Mn, and sometimes others; and βR to βFe, βAl, βCr, βMn; and several of these different metals may replace one another in the same specimen; and in different proportions in the same mineral from different localities; and the proportions appear to be at times indefinite. To clear away also these fractions arising from isomorphous substitutions would make formulas of great complexity, and in some cases almost as many different ones for a species as there may be localities if not analyses. And besides, the several formulas under a single species thus obtained would differ vastly in the number of atoms which they would indicate to be present in the different representatives of one and the same species, so that nature and chemical art would be put in direct variance.

There is no question that in most cases the formulas beyond should be taken in a multiple form in order to represent the true composition. Moreover, in examples of pleomorphism, such as garnet, allanite and biotite (epidote and idocrase may perhaps be included), the species probably differ by some simple ratio of multiples, as has been already explained. But until the exact multiple in any case has been ascertained, it appears to be best to retain the formula on the unit-scale here adopted. And even when ascertained, it may still be preferable to make the number expressing it a prefix to the whole formula here given, rather than to perform the multiplication with each member of it.

It may be objected to the following formulas that the βFe, βAl, γTi, &c., have only an ideal existence. But if in fact only ideal, they nevertheless belong *fundamentally* to the new system of chemistry. The metal in the sesquioxyds is capable of replacing *three* dyad elements, or *six* monads; and this the symbol recognizes. Moreover Fe^2 in Fe^2O^3 is a mere fiction, except as regards atomic weight; for Fe^3 is not Fe^3, or *two* of the dyad Fe, as it seems on the face of it to be. The fiction is avoided in the symbol adopted, and without implying any wrong idea with regard to the atomic weights.

Instead of using barred letters for the symbols of the elements whose atomic weights, in the new system, are double those of the old, I have employed small capitals for the remainder of them, that is, those of the perissads. The symbol of a perissad element is also indicated by the index $_{,}$ annexed to it; 2 of a monad replacing 1 dyad in these oxygen compounds. A list of the perissad elements will be found in the classification of the elements presented on a following page.*

I. UNISILICATES.

A. *Anhydrous.*

Forsterite,	$Si \vert O_4 \vert R_2$	$Si \vert O_4 \vert Mg_2$
Fayalite,	"	$Si \vert O_4 \vert Fe_2$
Tephroite,	"	$Si \vert O_4 \vert Mn_2$
Chrysolite,	"	$Si \vert O_4 \vert (Mg, Fe)_2$
Knebelite,	"	$Si \vert O_4 \vert (Fe, Mn)_2$
Willemite,	"	$Si \vert O_4 \vert Zn_2$
Phenacite,	"	$Si \vert O_4 \vert Be_2$
Garnet,	$Si \vert O_4 \vert (R, \beta R)_2$	$Si \vert O_4 \vert (\frac{1}{2}R+\frac{1}{2}\beta R)_2$
Meionite,	"	$Si \vert O_4 \vert (\frac{1}{2}R+\frac{1}{2}\beta R)_2$
Sarcolite,	"	$Si \vert O_4 \vert (\frac{1}{2}R+\frac{1}{2}\beta R)_2$
Allanite,	"	$Si \vert O_4 \vert (\frac{1}{2}R+\frac{1}{2}\beta R)_2$
Epidote,	"	$Si \vert O_4 \vert (\frac{1}{3}R+\frac{2}{3}\beta R)_2$
Zoisite,	"	$Si \vert O_4 \vert (\frac{1}{3}R+\frac{2}{3}\beta R)_2$
Piedmontite,	"	$Si \vert O_4 \vert (\frac{1}{3}R+\frac{2}{3}\beta R)_2$
Mellilite,	"	$Si \vert O_4 \vert (\frac{2}{3}R+\frac{1}{3}\beta R)_2$
Idocrase,	"	$Si \vert O_4 \vert (\frac{3}{5}R+\frac{2}{5}\beta R)_2$
Zircon,	$Si \vert O_4 \vert \gamma R_2$	$Si \vert O_4 \vert \gamma Zr_2$
Biotite,	$Si \vert O_4 \vert (\mathrm{K}_2, R, \beta R)_2$	$Si \vert O_4 \vert (\frac{1}{2}(\mathrm{K}_2, R)+\frac{1}{2}\beta R)_2$
Phlogopite A,	"	$Si \vert O_4 \vert (\frac{7}{11}(\mathrm{K}_2, R)+\frac{4}{11}\beta R)_2$
" B,	"	$Si \vert O_4 \vert (\frac{2}{3}(\mathrm{K}_2, R)+\frac{1}{3}\beta R)_2$
Lepidomelane, A,	"	$Si \vert O_4 \vert (\frac{1}{4}(\mathrm{K}_2, R)+\frac{3}{4}\beta R)_2$
" B,†	"	$Si \vert O_4 \vert (\frac{1}{2}(\mathrm{K}_2, R)+\frac{1}{2}\beta R)_2$
Astrophyllite,‡	$Si \vert O_4 \vert (\mathrm{B}_2, R, \beta R, \gamma R)_2$	$Si \vert O_4 \vert (\frac{10}{17}(\mathrm{B}_2, R)+\frac{3}{17}\beta R+\frac{4}{17}\gamma(Ti, Zr))_2$
Axinite,	$Si \vert O_4 \vert (R, \beta R, \delta \mathrm{B}_2)_2$	$Si \vert O_4 \vert (\frac{2}{7}R+\frac{4}{7}\beta R+\frac{1}{7}\delta \mathrm{B}_2)_2$

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* The author does not propose to substitute these new formulas for those of the old style in the forthcoming edition of his Mineralogy. They will appear only in tables by the side of the others.

† A is the original Lepidomelane as analyzed by Schlotheim, with which belongs also the Irish analyzed by Haughton. B is that of Rockport, Cape Ann, a brittle ferriferous mica intermediate in ratio between Lepidomelane and the magnesia mica, Biotite.

‡ From Pisani's analysis, C. R., lvi, 846.

B. *Hydrous.*

Calamine,	$Si\|O_4\|R_2+n\mathrm{aq}$	$Si\|O_4\|Zn_2+\frac{3}{2}\mathrm{aq}$
Cerite,	"	$Si\|O_4\|(Ce, La, Di)_2+\mathrm{aq}$
Thorite,	"	$Si\|O_4\|Th_2+2\mathrm{aq}$
Serpentine,*	$Si\|O_4\|(H_2, R)_2+n\mathrm{aq}$	$Si\|O_4\|(\frac{1}{4}H_2+\frac{3}{4}Mg)_2+\mathrm{aq}$
Deweylite,	"	$Si\|O_4\|(\frac{1}{3}H_2+\frac{2}{3}Mg)_2+\frac{4}{3}\mathrm{aq}$
Hydrophite,	"	$Si\|O_4\|(\frac{1}{3}H_2+\frac{2}{3}(Mg, Fe))_2+\frac{4}{3}\mathrm{aq}$
Genthite,	"	$Si\|O_4\|(\frac{1}{3}H_2+\frac{2}{3}(Mg, Ni))_2+\frac{4}{3}\mathrm{aq}$
Ekmannite,†	"	$Si\|O_4\|(\frac{1}{3}H_2+\frac{2}{3}(Fe, Mn))_2+\frac{1}{3}\mathrm{aq}$
Kaolinite,*	$Si\|O_4\|(H_2, \beta R)_2+n\mathrm{aq}$	$Si\|O_4\|(\frac{1}{4}H_2+\frac{3}{4}\beta Al)_2+\mathrm{aq}$
Gillingite,	$Si\|O_4\|(R, \beta R)_2+n\mathrm{aq}$	$Si\|O_4\|(\frac{1}{2}R+\frac{1}{2}\beta Fe)_2+2\mathrm{aq}$
Hisingerite,	$Si\|O_4\|(H_2, R, \beta R)_2+n\mathrm{aq}$	$Si\|O_4\|(\frac{1}{3}H_2+\frac{2}{3}(R, \beta Fe))_2+\frac{4}{3}\mathrm{aq}$
Neotocite,	"	$Si\|O_4\|(\frac{1}{3}H_2+\frac{2}{3}(R, \beta Mn))_2+\frac{4}{3}\mathrm{aq}$
Triclasite (Fahlunite),	"	$Si\|O_4\|(\frac{1}{5}H_2+\frac{1}{5}R+\frac{3}{5}\beta Al)_2$
Killinite,	"	$Si\|O_4\|(\frac{1}{3}H_2+\frac{2}{3}(R, \beta Al))_2$
Prehnite,	"	$Si\|O_4\|(\frac{1}{6}H_2+\frac{2}{6}Ca+\frac{3}{6}\beta Al)_2$
Pinite,*	$Si\|O_4\|(H_2, K_2, R, \beta R)$	$Si\|O_4\|(\frac{1}{4}H_2+\frac{3}{4}(K_2, R, \beta Al))_2$
Margarodite,	"	$Si\|O_4\|(\frac{2}{9}H_2+\frac{1}{9}(K_2, R)+\frac{6}{9}\beta Al)_2$
Œllacherite,‡	"	$Si\|O_4\|(\frac{1}{6}H_2+\frac{1}{6}(K_2, R)+\frac{4}{6}\beta Al)_2$
Paragonite,	$Si\|O_4\|(H_2, R_2, \beta R)$	$Si\|O_4\|(\frac{2}{12}H_2+\frac{1}{12}Na_2+\frac{9}{12}\beta Al)_2$
Damourite,	"	$Si\|O_4\|(\frac{2}{12}H_2+\frac{1}{12}K_2+\frac{9}{12}\beta Al)_2$
Euphyllite,	$Si\|O_4\|(R_2, \beta R)+n\mathrm{aq}$	$Si\|O_4\|(\frac{1}{9}(K, Na)_2+\frac{8}{9}\beta Al)_2+\frac{1}{3}\mathrm{aq}$

In several of the above species the water is all basic; in the others partly or wholly an accessory ingredient.

C. *With other accessory ingredients instead of water.*

Helvite,	$Si\|O_4\|R_2+$	$Si\|O_4\|(\frac{1}{2}(Mn, Fe)+\frac{1}{2}Be)_2+\frac{1}{3}MnS$
Danalite,	"	$Si\|O_4\|(\frac{1}{2}Mn, Fe, Zn)+\frac{1}{2}Be)_2+\frac{1}{3}ZnS$
Sodalite,	$Si\|O_4\|(R_2, \beta R)_2+$	$Si\|O_4\|(\frac{1}{4}Na_2+\frac{3}{4}\beta Al)_2+\frac{1}{3}Nacl$
Hauynite,	"	$Si\|O_4\|(\frac{1}{4}(R_2, R)+\frac{3}{4}\beta Al)_2+\frac{1}{3}S^a$
Nosite,	"	$Si\|O_4\|(\frac{1}{4}Na_2+\frac{3}{4}\beta Al)_2+\frac{1}{6}T^b$

[a] S=anhydrous sulphate of calcium. [b] T=anhydrous sulphate of sodium.

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* Serpentine, Kaolinite and Pinite are closely related in formula. The oxygen ratio for the bases, silica and water, in the first two is 3 : 4 : 2, in the last, 3 : 4 : 1. Pinite is an alumina-alkali serpentine, and Kaolinite (Pholerite, in part) an alumina serpentine, as pyrophyllite is an alumina talc.

Pinite includes many pseudomorphous potash silicates; as Liebnerite, Gieseckite, Dysyntribite, Pinitoid, Wilsonite, Lythrodes, Fellenberg's green mineral resembling compact green talc from the moraine of the Grindelwald glacier; and Gigantolite, Iberite, Polyargite, Rosellan appear to be impure conditions of the species.

† B. H. Ztg., xxvi, 21, 1867.

‡ Œllacher's margarite from Pfitschthal, Kenngott's Uebers., 1860, 49. The author has learned from Dr. Krantz that the margarite analyzed by Prof. G. J. Brush, to whom he furnished the specimen, is the original margarite, and that therefore Œllacher's is not so. Dr. Krantz in a note dated Bonn, March 17, 1867, says: "The specimen of margarite Prof. Brush obtained from me came from the Greiner mount in Tyrol. It occurs there in irregular masses in the mica slate in several varieties, passing from a pearl-white color into green and gray; it was formerly a very common mineral, but has of late become scarce. This was the only known locality in Tyrol, till Œllacher analyzed a mica of similar appearance, occurring with Rhætizite very near Kemmat in the Pfitsch valley in Tyrol, containing barytes, to which also he gave the name margarite. The two localities are about two and a half German or twelve English miles in a direct line from one another."

The species here included are all of the isometric system, the system which is peculiarly defiant of change from isomorphous substitutions; and they are alike of the *garnet* group.

II. Bisilicates.

A. *Anhydrous.*

Wollastonite,	$SiO\vert O_2\vert R$	$SiO\vert O_2\vert Ca$
Enstatite,	"	$SiO\vert O_2\vert Mg$
Kupfferite,	"	$SiO\vert O_2\vert Mg$
Grünerite,	"	$SiO\vert O_2\vert Fe$
Rhodonite,	"	$SiO\vert O_2\vert Mn$
Pyroxene,	"	$SiO\vert O_2\vert (Ca, Mg, Fe, Mn)$
Hypersthene,	"	$SiO\vert O_2\vert (Mg, Fe)$
Anthophyllite,	"	$SiO\vert O_2\vert (\frac{3}{4}Mg+\frac{1}{4}Fe)$
Amphibole, A,	"	$SiO\vert O_2\vert (Mg, Ca, Fe, Mn)$
" B,	"	$SiO\vert O_2\vert (H_2, Mg, Ca, Fe, Mn)$*
Babingtonite,	$SiO\vert O_2\vert (R, \beta R)$	$SiO\vert O_2\vert (\frac{3}{4}(Fe, Mn)+\frac{1}{4}\beta Fe)$
Beryl,	"	$SiO\vert O_2\vert (\frac{1}{2}Be+\frac{1}{2}\beta Al)$
Ægirine,	$SiO\vert O_2\vert (R_2, R, \beta R)$	$SiO\vert O_2\vert (\frac{1}{2}(Na_2, R)+\frac{1}{2}\beta Fe)$
Wichtisite,	"	$SiO\vert O_2\vert (\frac{1}{2}(Na_2, R)+\frac{1}{2}\beta Al)$
Acmite,	"	$SiO\vert O_2\vert (\frac{1}{3}(Na_2, R)+\frac{2}{3}\beta Fe)$
Arfvedsonite,	"	$SiO\vert O_2\vert (\frac{2}{5}(Na_2, R)+\frac{3}{5}\beta Fe)$
Spodumene,	$SiO\vert O_2\vert (R_2, \beta R)$	$SiO\vert O_2\vert (\ (Li_2, Na_2)+\frac{4}{5}\beta Al)$
Cryophyllite,	"	$SiO\vert O_2\vert (\frac{3}{7}(K_2, Li_2, R)+\frac{4}{7}\beta Al)$
Eudialyte,	$SiO\vert O_2\vert (R_2, R, \gamma R)$	$SiO\vert O_2\vert (\frac{2}{3}(Na_2, R)+\frac{1}{3}\gamma Zr)$†

B. *Hydrous.*

Talc, A,	$SiO\vert O_2\vert (H_2, R)$	$SiO\vert O_2\vert (\frac{1}{5}H_2+\frac{4}{5}Mg)$
" B,	$SiO\vert O_2\vert (H_2, R)+n\mathrm{aq}$	$SiO\vert O_2\vert (\frac{1}{5}H_2+\frac{4}{5}Mg)+\frac{1}{15}\mathrm{aq}$
Sepiolite (Meerschaum),	"	$SiO\vert O_2\vert (\frac{1}{3}H_2+\frac{2}{3}Mg)+\frac{1}{3}\mathrm{aq}$
Pyrophyllite,	$SiO\vert O_2\vert (H_2, \beta R)+n\mathrm{aq}$	$SiO\vert O_2\vert (\frac{1}{5}H_2+\frac{4}{5}\beta Al)+\frac{1}{15}\mathrm{aq}$
Cimolite,	"	$SiO\vert O_2\vert (\frac{1}{3}H_2+\frac{2}{3}\beta Al)+\frac{1}{3}\mathrm{aq}$
Okenite,	$SiO\vert O_2\vert (H_2, R)+n\mathrm{aq}$	$SiO\vert O_2\vert (\frac{1}{2}H_2+\frac{1}{2}Ca)+\frac{1}{2}\mathrm{aq}$
Laumontite,	$SiO\vert O_2\vert (R, \beta R)+n\mathrm{aq}$	$SiO\vert O_2\vert (\frac{1}{4}Ca+\frac{3}{4}\beta Al)+\mathrm{aq}$
Pectolite,	$SiO\vert O_2\vert (H_2, R_2, R)$	$SiO\vert O_2\vert (\frac{1}{6}H_2+\frac{5}{6}(Na_2, Ca))$
Dioptase,	$SiO\vert O_2\vert R+n\mathrm{aq}$	$SiO\vert O_2\vert Cu+\mathrm{aq}$

III. Subsilicates.

In the Subsilicates, the combining power of the silicon is less than that of the basic metal, the oxygen ratios for the bases and silicon being 3 : 2, 2 : 1, and 4 : 3, of which 3 : 2 is the most common. The only silicates of aluminum (or of an element in the beta state) known among minerals are Subsilicates; all the Uni-

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* Much amphibole contains some water; and according to Lechartier 1 to 1·5 p. c. exist in ordinary tremolite and other varieties, and this water requires a red heat to expel it. Making the water basic the ratio becomes 2 : 1 when not so without.

† Rammelsberg's analysis makes the oxygen ratio for $\dot{R}, \bar{R}, \dot{Si}=8{\cdot}93 : 4{\cdot}44 : 26{\cdot}62 = 2 : 1 : 6$.

silicates and Bisilicates containing aluminum contain also one or more basic metals in the *protoxyd* state.

The formulas of the mineral species here included are as follows, if the oxygen be not divided—the only method according to which they have been written in recent works on chemistry.*

A. *Anhydrous.*

	Ratio.		
Chondrodite,	4 : 3	$R_8\vert(O, F)_{14}\vert Si_3$	$Mg_8\vert(O, F)_{14}\vert Si_3$
Tourmaline,	4 : 3	$(R_2, R, \beta R, \delta R_2)_8\vert(O, F)_{14}\vert Si_3$	$(R_2, R, \beta Al\,\delta B_2)_8\vert(O, F)_{14}\vert Si_3$
Andalusite,	3 : 2	$\beta R_3\vert O_5\vert Si$	$\beta Al_3\vert O_5\vert Si$
Sillimanite,	3 : 2	“	$\beta Al_3\vert O_5\vert Si$
Kyanite,	3 : 2	“	$\beta Al_3\vert O_5\vert Si$
Gehlenite,	3 : 2	$(R, \beta R)_3\vert O_5\vert Si$	$(\frac{1}{2}R+\frac{1}{2}\beta R)_3\vert O_5\vert Si$
Sphene,	3 : 2	$(R, \gamma R)_3\vert O_5\vert Si$	$(\frac{1}{3}Ca+\frac{2}{3}\gamma Ti)_3\vert O_5\vert Si$
Tscheffkinite,	3 : 2	“	$(\frac{5}{8}R+\frac{3}{8}\gamma Ti)_3\vert O_5\vert Si$
Grothite,†	3 : 2	$(R, \beta R, \gamma R)_3\vert O_5\vert Si$	$(\frac{3}{8}Ca+\frac{1}{8}\beta Fe+\frac{4}{8}\gamma Ti)_3\vert O_5\vert Si$
Keilhauite,	3 : 2	“	$(\frac{5}{15}R+\frac{3}{15}\beta R+\frac{7}{15}\gamma Ti)_3\vert O_5\vert Si$
Topaz,	3 : 2	$\beta R_3\vert(O, F)_5\vert Si$	$\beta Al_3\vert(\frac{1}{2}O+\frac{1}{2}F)_5\vert Si$
Staurolite,‡	2 : 1	$(H_2, R, \beta R)_4\vert O_6\vert Si$	$(\frac{1}{5}(H_2, R)+\frac{4}{5}\beta R)_4\vert O_6\vert Si$
Schorlomite,	2 : 1	$(R, \beta R, \gamma R)_4\vert O_6\vert Si$	$(\frac{4}{11}R+\frac{3}{11}\beta R+\frac{4}{11}\gamma R)_4\vert O_6\vert Si$

B. *Hydrous.*

	Ratio.		
Pyrosclerite,	4 : 3	$(H_2, R, \beta R)_8\vert O_{14}\vert Si_3+n\,aq$	$(\frac{1}{4}H_2+\frac{2}{4}R+\frac{1}{4}\beta R)_8\vert O_{14}\vert Si_3+2aq$§
Pennine,	“	$(R, \beta R)_8\vert O_{14}\vert Si_3+n\,aq$	$(\frac{2}{3}R+\frac{1}{3}\beta R)_8\vert O_{14}\vert Si_3+4aq$‖
Ripidolite,	“	“	$(\frac{5}{8}R+\frac{3}{8}\beta R)_8\vert O_{14}\vert Si_3+4aq$‖
Cookeite,	“	$(H_2, R_2, \beta R)_8\vert O_{14}\vert Si_3+n\,aq$	$(\frac{1}{12}H_2+\frac{1}{12}(Li, K)_2+\frac{10}{12}\beta Al)_8$ $\vert O_{14}\vert Si_3+3aq$

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* The principles of the new system seem to suggest for the rational formula one of the two following methods; which of the two, I leave for others to decide.

	Ratio 3 : 2.	Ratio 2 : 1.	Ratio 4 : 3.
I.	$(R, \beta R)O\vert O_4\vert Si$	$(R, \beta R)O_2\vert O_4\vert Si$	$(R, \beta R)O_2\vert O_{12}\vert Si_3$
II.	$(R, \beta R)O_2\vert O_2\vert SiO$	$(R, \beta R)O_3\vert O_2\vert SiO$	$(R, \beta R)O_9\vert O_2\vert Si_3O_3$

† Described as a variety of Titanite by Groth in the Jahrb. Min., 1866, p. 44.

‡ Lechartier has found (Bull. Soc. Ch., II, iii, 378, 1865) that the variations in the silica, etc., observed in staurolite by Rammelsberg are due to impurities, and that after separating the impurities, the amount of silica is uniformly 28·1 to 29·2 p. c.; and further, that 1·3 to 1·5 p. c. of water were present in the pure staurolite, which required near red heat to expel it.

§ From von Kobell's analysis. The ratio is 1 : 1 if the water be excluded; but 4 : 3 as in Pennine, if half the water be made basic. As in the case of the silicate group generally, and many other hydrous silicates, the true constitution must remain in doubt until the state of the water has been definitively determined.

‖ Pennine affords in part the ratio 5 : 4, but 4 : 3 is probably the true ratio. Optically Pennine is hexagonal, and *Ripidolite* (Clinochlore) monoclinic. Von Kobell's name, Ripidolite, has priority; and, moreover, a second kind of Clinochlore or monoclinic Chlorite exists; the *Corundophilite* of Chester, Mass., having been found to have the optical bisectrix oblique to the plane of cleavage by Descloizeaux, and later by Prof. J. P. Cooke (this vol., p. 206). There are hence *two hexagonal* and *two monoclinic* chlorites. The Corundophilite approaches more nearly the hexagonal chlorite in composition than Ripidolite (Clinochlore); the formula for it is from Pisani's analysis, whose specimens were optically examined by Descloizeaux.

Since *Chlorite* has become the name of a group of species, the hexagonal chlorite requires another name; and it is accordingly designated above *Prochlorite*, it being the *first* crystallized chlorite recognized by Werner.

Euclase,	3 : 2	$(H_2, R, \beta R)_3 \| O_5 \| Si$	$(\frac{1}{6}H_2+\frac{2}{6}Be+\frac{3}{6}\beta Al)_3 \| O_5 \| Si$
Datolite,	"	$(H_2, R, \delta R)_3 \| O_5 \| Si$	$(\frac{1}{6}H_2+\frac{2}{6}Ca+\frac{3}{6}\delta B_2)_3 \| O_5 \| Si$
Prochlorite,	"	$(R, \beta R)_3 \| O_5 \| Si+n aq$	$(\frac{4}{7}R+\frac{3}{7}\beta Al)_3 \| O_5 \| Si+1\frac{1}{3}aq$*
Cronstedtite,	"	"	$(\frac{1}{2}R+\frac{1}{2}\beta Fe)_3 \| O_5 \| Si+1\frac{1}{2}aq$
Corundophilite,	2 : 1	$(R, \beta R)_4 \| O_6 \| Si+n aq$	$(\frac{1}{2}R+\frac{1}{2}\beta R)_4 \| O_6 \| Si+1\frac{2}{3}aq$*
Chloritoid,	"	"	$(\frac{1}{4}R+\frac{3}{4}\beta R)_4 \| O_6 \| Si+aq$
Margarite,	"	$(H_2, R, \beta R)_4 \| O_6 \| Si$	$(\frac{1}{8}H_2+\frac{1}{8}R+\frac{6}{8}\beta R)_4 \| O_6 \| Si$
Thuringite,	"	"	$(\frac{1}{6}H_2+\frac{2}{6}R+\frac{3}{6}\beta R)_4 \| O_6 \| Si$
Seybertite,	3 : 1	$(R, \beta R)_6 \| O_8 \| Si+n aq$	$(\frac{2}{5}R+\frac{3}{5}\beta R)_6 \| O_8 \| Si+\frac{1}{5}aq$†
Xanthophyllite,	4 : 1	$(R, \beta R)_8 \| O_{10} \| Si+n aq$	$(\frac{3}{8}R\mp\frac{5}{8}\beta R)_8 \| O_{10} \| Si+aq$‡

The species Ilvaite, from Elba, appears from the analyses to fall among Subsilicates. But the oxygen ratio between the basic metals and the silicon varies in the analyses from 5 : 4 to 9 : 8; and in the mineral from Nassau, regarded as the same species (Tobler, Journ. Ch. Pharm., xcix, 122), the ratio is 1 : 1. Städeler states that 1 to 2 p. c. of water is always present which is expelled only by the heat of ignition; and making the water basic, arrives at the ratio 5 : 4 for the species. Another view, perhaps quite as probable, considering the opacity of the species and Lechartier's results with staurotide, is that the mineral of Elba contains some $\bar{F}e\bar{H}$ (Göthite) as impurity; and that this causes the divergence from the ratio 1 : 1.

IV. INTERMEDIATE SILICATES.

The silicates in which the oxygen ratio for the basic metals and silicon is between 1 : 1 and 1 : 2 have been called *Parasilicates* by Odling, being regarded as combinations of a Unisilicate and Bisilicate. The ratio

1 : 1½,	occurs in	Leucophane and Lepidolite,	and would	correspond to	1U + 2B
1 : 1¼	"	Muscovite and Iolite,	"	"	1½U + 1B
1 : 1⅛	"	Nepheline,	"	"	3½U + 1B

The discovery by Prof. J. P. Cooke of a bisilicate mica, cryophyllite, has led this chemist to sustain the view that the micas are isomorphous combinations of the above kind, the group now including three or more Unisilicates, one Bisilicate, and the two intermediate species, lepidolite and muscovite.

Besides the above species of intermediate silicates there are the various compounds grouped under the species Wernerite (Scapolite) together with the related Meionite and Mizzonite. The minerals here alluded to have the same crystallization and belong to one group, and, according to Rose, and others to one species, Meionite. The divergence from the unisilicate ratio has

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* See note (‖) on preceding page.

† From the analyses by Brush, who obtained but 1·50 p. c. of water, more than half less than other analysts had found.

‡ From Meitzendorf's analyses.

been attributed to alteration, and to impurities; and also by others to a variation in chemical ratio analogous to that among the feldspars. I pass the subject without discussion.

The species of Silicates which remain are the Feldspars and the Zeolites. The Feldspars may be regarded as *unisilicate* in anorthite; *bisilicate* in andesine and leucite; *tersilicate* in albite and orthoclase; 1½-*silicate* in labradorite; 2¼-*silicate* in oligoclase. But this view would disband one of the most natural groups of silicates, and introduce the only example of a *tersilicate* among anhydrous silicates. I have seen no satisfactory explanation of the unity of the group, and am not prepared to offer one. The theory of the Zeolites seems to be one with that of the Feldspars.*

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* Tschermak has proposed a method of deducing a common formula for the Feldspars which has had some favor, and may have here a passing remark. At the extremes in the series of feldspars are *Anorthite* and *Albite*, the former containing calcium, aluminum and silicon, with the oxygen ratio 1 : 3 : 4; and the latter sodium, aluminum and silicon, with the ratio 1 : 3 : 12. Tschermak brings these extremes under one formula as follows. By making the number of atoms of oxygen in the two the same (which is done by doubling the Anorthite), the sum of the number of equivalents of aluminum and silicon (taking silica as SiO^2) in the two is the same; and also, if we write Na_2 for Na, in accordance with the new chemistry, the number of atoms of protoxyds is the same. Then, assuming that the Al and Si are replaceable 1 for 1, and K, Ca, 1 for 1, the formulas become, for

Albite, $\mathrm{Na}^2\ \mathrm{Al}^2\ \mathrm{Si}^2\ \mathrm{Si}^4\ \mathrm{O}^{16}$
Anorthite, $\mathrm{Ca}^2\ \mathrm{Al}^2\ \mathrm{Al}^2\ \mathrm{Si}^4\ \mathrm{O}^{16}$

and are parallel throughout. The result *looks* well. But this substitution, atom for atom, of a tetrad (Si) and a pseudotriad (Al), and also of a monad (Na) and a dyad (Ca), is an impossibility. It takes two of a monad to replace a dyad.

If silicon may be basic and replace aluminum it is a much simpler method of arriving at like formulas for the species (and one correct in the ratio in which Si and Al may replace one another) to make a direct transfer as follows: The first column contains the oxygen ratios, as ordinarily given; the second, the same with part of the silica transferred to the bases and added to the alumina; the third, the resulting general ratio for the bases and silica.

	Oxygen ratio. $\dot{R}$ $\ddot{\bar{R}}$ $\ddot{Si}$	Oxygen ratio. $\dot{R}$ $\ddot{\bar{Al}}+\ddot{Si}$ $\ddot{Si}$	Oxygen ratio. Bases : Silica.
Anorthite,	1 : 3 : 4	1 : 3 + 0 : 4	1 : 1
Labradorite,	1 : 3 : 6	1 : 3 + 1 : 5	1 : 1
Andesite,	1 : 3 : 8	1 : 3 + 2 : 6	1 : 1
Oligoclase,	1 : 3 : 9	1 : 3 + 2½ : 6½	1 : 1
Albite, Orthoclase,	1 : 3 : 12	1 : 3 + 4 : 8	1 : 1

The species are thus all reduced to *Unisilicates*, of the Anorthite and Garnet type, with the general formula

$$\mathrm{Si}|\mathrm{O}_4|(\mathrm{R}_2,\ \mathrm{R},\ \beta\mathrm{Al},\ \gamma\mathrm{Si})_2;$$

and, accordingly, the following would be the special formulas of Anorthite, Labradorite and Albite:

Anorthite, $\mathrm{Si}|\mathrm{O}_4|(\tfrac{1}{4}\mathrm{R}+\tfrac{3}{4}\beta\mathrm{Al})_2$
Labradorite, $\mathrm{Si}|\mathrm{O}_4|(\tfrac{1}{5}(\mathrm{Na}_2,\ \mathrm{Ca})+\tfrac{3}{5}\beta\mathrm{Al}+\tfrac{1}{5}\gamma\mathrm{Si})_2$
Albite, $\mathrm{Si}|\mathrm{O}_4|(\tfrac{1}{8}\mathrm{Na}_2+\tfrac{3}{8}\beta\mathrm{Al}+\tfrac{4}{8}\gamma\mathrm{Si})_2$

Formulas for the others may be written in the same manner.

8. *Classification of the Elements.*—On page 94 of my former paper, it was stated, among the inferences from the principles discussed, that the metals in their different states, as indicated by their different grades of combinations, that is, αR, βR, γR, δR, ϵR, should be arranged in different groups in a classification of the elements. This principle has been, in part, for some time admitted. The following scheme of classification, thus made out, in brief, is here introduced as a supplement to the preceding tables of formulas, to make more manifest the general relations of the elements in their different states, and to present to view the author's reasons for regarding zirconium in zircon, eudialyte, astrophyllite, etc.; titanium in sphene, keilhauite, astrophyllite, etc.; boron in axinite, datolite, tourmaline, *basic* metals, and the compounds with silicon silicates, while at the same time the near relation between these metals and silicon is fully admitted.

Classification of the Elements.

Series I.	**Series II.**	**Series III.**
A. *Perissads* (Monads).	A. *Perissads.*	A. *Perissads* (Monads).
Potassium, Sodium, Cæsium, Rubidium, Lithium, Thallium, Hydrogen, Silver, Gold.	Nitrogen, Phosphorus, Arsenic, Antimony, Bismuth, Columbium, Tantalum. Boron.	Chlorine, Bromine, Iodine.
B. *Artiads.*	B. *Artiads.*	B. *Artiads.*
1. IRON-ALUMINUM GROUP.	1. SULPHUR GROUP.	
a. IRON SUB-GROUP. — Platinum, etc., Copper, Lead, etc., Iron, Cobalt, Zinc, Cadmium, Nickel, Manganese, Chromium, Tungsten, etc., Cerium, Yttrium, etc., Magnesium, Calcium, Strontium, Barium; also H_2, K_2, Na_2, etc.		*a.* Fluorine.
b. ALUMINUM SUB-GROUP.—Aluminum (βAl); also βFe, βMn, βCr, etc.	Sulphur (δS), Selenium, Tellurium, Molybdenum; also δFe, δCr, δMn, δV, δW, δAs_2, δB_2.	*b.* Oxygen.
2. TIN GROUP.	2. CARBON-SILICON GROUP.	
Tin, Titanium, Zirconium, Thorium; also γH, γFe, γMn, γCo, γPb, γCu, etc.	Carbon, Silicon; also γS, γSe, γTe, etc.	

It is observed that in this classification *three* series of elements are recognized, which are designated by numbers, Series I, II, III. They might be called the *basic, medial*, and *acidic* series; or the *basic, subacidic*, and *peracidic*. But it seems as well to call them simply by their numbers, since, owing to the diversities among the species of each series, the above descriptive names are only in a general way, and not specifically, applicable.

The classification is, in our view, a natural one, whether read vertically or transversely.

Looking at it vertically, the three series correspond severally with the three grades of elements in the oxygen ternary compounds or salts, the acidic element being of Series III; the second element in order, silicon, of Series II; and the basic metals of Series I. The elements of Series I are eminently the basic elements. Among those of Series II arsenic and others of the first group often replace isomorphically sulphur of the second group; and RO^2 of the sulphur group makes salts that are isomorphous with those of CO^2. The near relations of the species of Series III have always been recognized.

Viewing the arrangement horizontally, the three Divisions A, at the top of the series, include the Perissads, or those elements the ratios of whose combinations are by *odd* numbers, as 1 : 1, 1 : 3, 2 : 3, etc.; while the three Divisions B, across, include the Artiads, or those whose combinations are by *even* numbers, as 2 : 2 (in the Iron Sub-group), 4 : 6 (in the Aluminum Sub-group), 2 : 4 (in the Tin Group and Carbon-Silicon Group), 2 : 6 (in the Sulphur Group). The recognition of this distinction of odd and even is universally regarded as one of the most important deductions of modern chemical science.

Again, opposite the Iron-Aluminum Group in Series I, stands the Sulphur group in Series II; and many metals which are represented in the Iron-Aluminum Group are also represented in the Sulphur Group. Again, Oxygen, of Series III, stands opposite Sulphur of Series II, whose relations to oxygen are fundamental.

Again, the Tin Group in Series I is in the same horizontal division with the Carbon-Silicon Group in Series II. The mutual relations of the two are thus recognized; and, also, by the arrangement in distinct series, the actual diversity as to their grade in ternaries. For silicon stands on a virtually higher level than tin and titanium, and throws the latter into the inferior basic relation whenever they occur together. As Ti joins with Fe to form with oxygen a sesquioxyd, closely isomorphous with hematite (Fe^2O^3) and also physically like it, so Ti may join with Ca (as in Perofskite) or with any other metal of that sub-group, in a sesquioxyd; and so also it may be basic in any combination with silica, as in sphene, etc., page 258. Accordingly, also, SiO^2 and ZrO^2 make together, not a mere combination of two coördinate isomorphs, but a true Unisilicate, as recognized in the formula on page 255. The formulas of the silicates which have been given and the classification we regard as mutually illustrating and sustaining one another.

Fluorine is placed among the Artiads, because of its frequent replacement of oxygen, the analogies of its ternaries with those of oxygen, and the nature of some other of its compounds, although it acts in many cases as a Perissad. But with regard to it no special relation in a horizontal view of the classification is intended to be indicated.*

ART. XXX.—*Formic versus Carbonous acid;* by GEORGE F. BARKER.

IN studying the primary oxyds of the negative simple radicals, (the acids) for the purpose of classification, it is evident that the equivalence of the radical varies in each of the acids which it forms. In sulphuric acid, sulphur is a hexad, while in sulphurous acid it is a tetrad and in hyposulphurous acid a dyad. Conversely we may expect to find as many acids as the radical by such changes in its equivalence, can produce. Phosphoric acid contains phosphorus as a pentad; but since this radical may act as a triad, phosphorous acid is thus predicted. In the case of the tetrad carbon we have carbonic acid; but since carbon may act as a dyad, carbonous acid is also possible. I propose to give here some of the arguments which may be adduced to show that formic acid is the acid in question.

1. The formula of formic acid, usually written $\left.\begin{matrix}(\text{Є}\text{H}\Theta)\\ \text{H}\end{matrix}\right\}\Theta$, may equally well be written $\left.\begin{matrix}\text{Є}''\\ \text{H}_2\end{matrix}\right\}\Theta_2$, both being equal to $\text{H}_2\text{Є}\Theta_2$, corresponding to carbonic acid $\text{H}_2\text{Є}\Theta_3$. Potassic formate $\left.\begin{matrix}(\text{Є}\text{H}\Theta)\\ \text{K}\end{matrix}\right\}\Theta$ equals $\left.\begin{matrix}\text{Є}\\ \text{HK}\end{matrix}\right\}\Theta_2$, and the ethers $\left.\begin{matrix}(\text{Є}\text{H}\Theta)\\ (\text{Є}_n\text{H}_{2n+1})\end{matrix}\right\}\Theta$ may be $\left.\begin{matrix}\text{Є}\\ \text{H}(\text{Є}_n\text{H}_{2n+1})\end{matrix}\right\}\Theta_2$.

2. Hofmann's formamid $\left.\begin{matrix}(\text{Є}\text{H}\Theta)\\ \text{H}\\ \text{H}\end{matrix}\right\}\text{N}$ may be viewed as $\left.\begin{matrix}(\text{Є}'')\text{H}_2\text{N}\\ \text{H}\end{matrix}\right\}\Theta$ carbimic acid, corresponding to carbamic acid $\left.\begin{matrix}(\text{Є}\Theta)\text{H}_2\text{N}\\ \text{H}\end{matrix}\right\}\Theta$. Especially since ethyl-formamid $\left.\begin{matrix}(\text{Є}\text{H}\Theta)\\ \text{Є}_2\text{H}_5\\ \text{H}\end{matrix}\right\}\text{N}$ may be ethylic carbimate $\left.\begin{matrix}(\text{Є}'')\text{H}_2\text{N}\\ \text{Є}_2\text{H}_5\end{matrix}\right\}\Theta$.

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* Near the last of June, Prof. G. Hinrichs, of Iowa University, published in German a memoir on *Atom Mechanics*, which, while the views are widely different, has some points of agreement with my paper in the July number of this Journal. A copy of the memoir reached this place July 2d, after my paper was printed, but nearly three weeks before the July number was issued. I had intended to have an abstract of it in this number, but am unable to accomplish it, and therefore defer it to our next.

3. The radical formyl ($\text{ЄH}\Theta$), unlike acetyl ($\text{Є}_2\text{H}_3\Theta$), is not required to formulate the derivatives of the acid. Moreover, no chlorid or hydrid of this radical exists. The anhydrous acid (formylic oxyd), too, $\left.\begin{matrix}(\text{ЄH}\Theta)\\(\text{ЄH}\Theta)\end{matrix}\right\}\Theta$ is unknown. If, however, the acid be $\left.\begin{matrix}\text{Є}\\\text{H}_2\end{matrix}\right\}\Theta_2$, then its secondary oxyd would be $\text{Є}''\}\Theta$, carbonic oxyd.

4. Its synthesis. We have—*a*, Berthelot's method,

$$\text{HK}\Theta+\text{Є}\Theta=\text{HKЄ}\Theta_2\text{; just as }\text{HK}\Theta+\text{Ꞩ}\Theta_2=\text{HKꞨ}\Theta_3.$$

b, Kolbe's method by deoxydizing $\text{H}_2\text{Є}\Theta_3$,

$$(\text{H}_2\text{Є}\Theta_3)_2+\text{Na}_2=\text{HNaЄ}\Theta_2+\text{HNaЄ}\Theta_3+\text{H}_2\Theta.$$

c, Dupré's method, $\text{H}_2\text{Є}\Theta_3+\text{Є}+\text{H}_2\Theta=(\text{H}_2\text{Є}\Theta_2)_2$; similar to $\text{H}_2\text{Ꞩ}\Theta_3+\text{Ꞩ}+\text{H}_2\Theta=(\text{H}_2\text{Ꞩ}\Theta_2)_2$.

d, Chapman's method, partial oxydation of carbon,

$$\text{Є}+\Theta+\text{H}_2\Theta=\text{H}_2\text{Є}\Theta_2.$$

5. Its preparation. *a*, from oxalic acid $\text{H}_2\text{Є}_2\Theta_4=\text{H}_2\text{Є}\Theta_2+\text{Є}\Theta_2$, as well as the reverse action; *b*, from cyanhydric acid

$$\left.\begin{matrix}\text{Є}''\\\text{H}\end{matrix}\right\}\text{N}+\left.\begin{matrix}\text{H}_2\\\text{HK}\end{matrix}\right\}\Theta_2=\left.\begin{matrix}\text{Є}''\\\text{HK}\end{matrix}\right\}\Theta_2+\left.\begin{matrix}\text{H}_2\\\text{H}\end{matrix}\right\}\text{N}.$$

And in general its production from the oxydation of carbonaceous materials. In no case is the intermediate body formic aldehyd, obtained; this anomalous result is accounted for if the acid be $\left.\begin{matrix}\text{Є}''\\\text{H}_2\end{matrix}\right\}\Theta_2$.

6. Its decompositions. Like sulphurous and similar acids, it readily reduces metallic salts; it is oxydized readily by platinum black; by action of $\text{H}_2\text{Ꞩ}\Theta_4$, $\text{H}_2\text{Є}\Theta_2$ gives $\text{H}_2\Theta$ and $\text{Є}\Theta$, the anhydrid; the action of PCl_5 produces no formylic chlorid, $\text{H}_2\text{Є}\Theta_2+\text{PCl}_5=\text{PCl}_3\Theta+\text{Є}\Theta+(\text{HCl})_2$; chlorine gives $\text{H}_2\text{Є}\Theta_2+\text{Cl}_2=\text{Є}\Theta_2+(\text{HCl})_2$.

7. Its acknowledged divergence from the acetic or fatty acid series, in which it is usually classed. These acids resist the oxydizing action of dilute chromic acid, while formic acid on the other hand is a powerful reducing agent.

From the above statements, it is clear that this question turns on the fact whether this acid is mono or dibasic. Just now, the former has the preference. True we may view the formates as acid carbonites, but the anomaly of an acid, all of whose salts are acid salts, remains. A basic plumbic formate $\left.\begin{matrix}\text{Pb}''\\\text{H}(\text{ЄH}\Theta)\end{matrix}\right\}\Theta$, corresponding to the acetate $\left.\begin{matrix}\text{Pb}''\\\text{H}(\text{Є}_2\text{H}_3\Theta)\end{matrix}\right\}\Theta$, if known, might have the formula $\text{Pb}''\text{Є}\Theta_2+\text{H}_2\Theta$, plumbic carbonite.

The fact of its formation by the partial oxydation of carbon, and also, by the deoxydation of carbonic acid, are however, most cogent arguments in favor of the acid of bivalent carbon.

New Haven, Sept. 1st, 1867.

ART. XXXI.—*Observations on Skylight Polarization in Nebraska during the month of July*, 1867; by EDWARD O. CHASE.

THE following observations were made at various stations of the U. S. Geological Survey, with an excellent Savart polariscope, of remarkable clearness. I mark the neutral points as follows: Ar., Arago's; Ba., Babinet's; Br., Brewster's.

July 1.—Cloudy.

2.—6^h 30^m P.M., Ar., Ba., both faint. Clouds below the sun.

3, 4.—Cloudy.

5.—12 M., Br., distinct. 6^h 30^m P.M., Ba., faint.

6.—Heavy rain in A.M. 6^h 30^m P.M., Ba., faint.

7.—7^h 15^m A.M. and 5^h 45^m P.M., Ba., faint.

8.—6^h 10^m A.M., Ar., distinct, Ba., faint. 6^h 30^m P.M., Ar., Ba., equally distinct.

9.—Cloudy in A.M. 7^h P.M., Ar., faint; Ba., distinct.

10.—Ba., distinct; Br., faint. Stormy in P.M.

11.—Cloudy and stormy.

12.—8^h 30^m A.M., Ba., Br., both faint. 7^h P.M., Ar., Ba., equally distinct.

13.—7^h A.M., Ar., distinct; Ba., faint. 7^h 15^m P.M., Ar., very distinct; Ba., distinct.

14.—Cloudy and rainy.

15.—6^h 30^m A.M., Ar., very distinct; Ba., faint; Br., distinct. This was the only instance in which the three points were observed simultaneously.* 7^h 25^m P.M., Ar., very distinct; Ba., faint.

16.—8^h A.M., Ba., very distinct; Br., faint. 7^h P.M., Ar., very distinct; Ba., faint.

17, 18.—Cloudy.

19.—6^h 30^m P.M., Ar., very distinct; Ba., distinct.

20.—6^h P.M., Ar., very distinct.

21.—6^h A.M., Ar., very distinct; Ba., distinct.

22.—6^h P.M., Ar., Br., equally distinct. 7^h 15^m P.M., Ar., very distinct; Ba., distinct.

23.—7^h 30^m P.M., Ar., very distinct; Ba., distinct.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the synthesis of organic acids.*—CARIUS has made the very interesting and important discovery that chlorous acid like hypochlorous acid unites directly with hydrocarbons to form chlorinated organic acids. In his first memoir the author describes the product of the action of chlorous acid upon benzol under the name of trichlorphenomalic acid, the reaction by which the new acid is formed being represented by the equation

$$€_6H_6+(ClH\Theta_2)_3=€_6H_7Cl_3\Theta_5+\Theta H_2.$$

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* For analogous observations see this Journal, II, xlii, 112, 113.

Trichlorphenomalic acid may be regarded as a chlorinated derivative of an acid homologous with malic acid, $\Theta_3 \left\{ \begin{matrix} Є_6H_7\Theta_2 \\ H_3 \end{matrix} \right.$; the acid is colorless, crystalline and soluble in water, alcohol, benzol and ether. Its density when fused and solidified is 1·5, at 131°–132° C. it fuses, and at a few degrees higher gives off vapors of water and a new acid. Reducing agents convert the acid apparently into another acid having the formula $Є_6H_{10}\Theta_5$, but with a larger excess of tin, and strong chlorhydric acid succinic acid is formed, with small quantities of another acid not yet studied. With an excess of solution of baryta trichlorphenomalic acid yields a new acid, the reaction being

$$Є_6H_7Cl_3\Theta_5+(BaH\Theta)_6=3BaCl+Є_6H_3Ba_3\Theta_6+5(\Theta H_2).$$

The author terms this acid phenaconic acid, and describes a number of its salts. In addition to the crystallized trichlorphenomalic acid, an amorphous acid having the same constitution is found among the products of the action of chlorous acid upon benzol. This acid yields with reducing agents new acids free from chlorine which with their salts are also amorphous. Chemists will await with much interest the results of the researches of Carius upon the action of chlorous acid upon naphtalin which promise to connect this body with the aromatic and through this with the fatty series.—*Ann. der Chemie und Pharm.*, cxlii, 129. W. G.

2. *On the action of heat upon benzol and analogous hydrocarbons.*—Berthelot has studied the action of heat upon various hydrocarbons and has arrived at many interesting and valuable results. When benzol is passed through a porcelain tube heated to bright redness, it is partially decomposed with formation of several definite hydrocarbons which stand in very simple relations to benzol itself. The chief product is phenyl, a beautiful crystalline substance which has the formula

$$(C_{12}H_5)_2=C_{24}H_{10}\,(2C_{12}H_6=C_{24}H_{10}+2H).$$

The author considers it as formed from benzol by the replacement of two atoms of hydrogen by an equal volume of benzol so that $C_{12}H_4(C_{12}H_6)$ results. The phenyl obtained in this way is identical with that Fittig obtained by the action of sodium upon brominated benzol, but the method of preparation is more advantageous than that of Fittig. Above 360° C., a waxlike yellowish substance very slightly soluble in alcohol passes over, which is identical with chrysen. Berthelot gives this body the formula $C_{36}H_{12}$, $(3C_{12}H_6=C_{36}H_{12}+6H)$ and considers it a polymer of the unknown hydrocarbon $C_{12}H_4$. After chrysen an orange colored resinous solid body passes over which is almost insoluble in alcohol which it however causes to fluoresce and which gives with picric acid a slightly soluble peculiar compound. In the retort there remains a fluid hydrocarbon which does not volatilize at a red heat and which on cooling gives a black and brittle bitumen. All these hydrocarbons result from the condensation of a variable number of molecules of benzol with evolution of hydrogen. Naphtalin and anthracen are not present even in small quantities. Toluol like benzol is partially decomposed by passing through a red hot tube. The products of the action by careful rectification were found to be benzol in large quantity, unaltered toluol in still larger quantity, naphtalin, a small quantity of a crystallized hydrocarbon boiling at about 270° C., and a larger quantity of a fluid hydrocarbon which is perhaps benzyl $(C_1H_7)_2$ or an isomer. The boiling point then rises above 360° C., when a large quantity of an indistinctly crystallized hydrocarbon passes over mixed with a liquid. The first is anthracen $(C_{14}H_5)_2$; the others are analogues of chrysen and the last derivatives of benzol. Benzyl is derived from toluol in the same manner a sphenyl from benzol; $2C_{14}H_8=C_{28}H_{14}+H_2$. Anthracen is derived from toluol by a similar condensation and subtraction of hydrogen $2C_{14}H_8=C_{28}H_{10}+3H_2$. As, according to Berthelot's view, toluol may be derived from benzol by the substitution of marsh-gas for hydrogen, benzol $=C_{12}H_4(H_2)$, toluol $=C_{12}H_4(C_2H_2)$. Anthracen may be considered as formed by the union of the benzol residue $C_{12}H_4$ with the marsh-gas residue C_2H and has therefore the rational formula $[C_{12}H_4(C_2H)]_2$, that is, $C_{12}H_4[C_{12}H_4(C_4H_2)]$. This explains why a marsh-gas residue is necessary for the formation of anthracen and why this hydrocarbon is not formed in the decomposition of pure benzol. The formation of benzol from toluol is according to all analogy, being merely the derivation of a lower from a higher homologue. The marsh-gas residue serves to form naphtalin according to the equation

$$4C_{14}H_8=3C_{12}H_6+C_{20}H_8+3H_2.$$

When a mixture of benzol and ethylen, C_4H_4, is passed through a red hot tube the following products are obtained. (1) Styrolen $C_{16}H_8$ in large quantity well defined and without any more volatile product, except benzol; (2) naphtalin, $C_{20}H_8$; (3) another crystallizable hydrocarbon resembling phenyl and boiling at about 260° C., but forming a characteristic compound with picric acid which phenyl does not do; (4) anthracen in considerable quantity mixed with a fluid hydrocarbon, etc. The formation of styrolene may be represented by the equation

$$C_{12}H_6+C_4H_4=C_{16}H_8+H_2.$$

Naphtalin is formed by the reaction $C_{12}H_6+2C_4H_4=C_{20}H_8+3H_2$, which, according to Berthelot, leads to the rational formula, $C_{12}H_4[C_4H_2(C_4H_2)]$, so that naphtalin is formed from benzol by two successive substitutions, one of H_2 by C_4H_4 forming styrolene, $C_{12}H_4(C_4H_4)$, the second of H_2 in C_4H_4 by C_4H_2. Anthracen is formed according to the reaction $2C_{12}H_6+C_4H_4=C_{28}H_{10}+3H_2$.
which leads to the rational formula $C_{12}H_4[C_{12}H_4(C_4H_2)]$.

Pure styrolene is partially decomposed at a red heat with formation of benzol and acetylene $C_{16}H_8=C_{12}H_6+C_4H_2$.
Again benzol and acetylene heated together produce a certain quantity of styrolene, though this hydrocarbon is not the chief product. When styrolene and hydrogen, $C_{16}H_8+H_2$, are heated together in a closed tube, benzol and ethylene are formed. In this case, however, the greater part of the styrolene is directly converted into benzol according to the equation $3C_{16}H_8=4C_{12}H_6$.

Styrolene and ethylene heated together, $C_{16}H_8+C_4H_4$, yield benzol and naphtalene both in considerable quantity. The benzol results from the decomposition of the styrolene itself but the naphtalin is formed by the direct action of ethylene upon styrolene:

$$C_{12}H_4[C_4H_2(H_2)]+C_4H_2(H_2)=C_{12}H_4[C_4H_2(C_4H_2)]+2H_2.$$

Benzol and styrolene passed together through a red hot tube gave anthracene in large quantity, together with naphtalin and a hydrocarbon resembling phenyl. The anthracene results from the direct action of the styrolene upon benzol according to the equation

$$C_{12}H_4[C_4H_2(H_2)]+C_{12}H_4(H_2)=C_{12}H_4[C_{12}H_4(C_2H_2)]+2H_2.$$

Berthelot thinks that in this case the naphtalin results from the action of the free hydrogen upon the styrolene forming ethylene and benzol, while the ethylene reacts upon another portion of styrolene to join naphtalin. Benzol and naphtalin exert no action upon each other at a red heat, but the benzol is alone decomposed. At a bright red heat anthracene is found in large quantity.

$$C_{12}H_4[C_4H_2(C_4H_2)]+3C_{12}H_4(H_2)=2C_{12}H_4[C_{12}H_4(C_4H_2)]+3H_2.$$

Phenyl heated to redness with hydrogen in a closed glass tube is partially decomposed with formation of benzol and chrysen:

$$3C_{24}H_{10}=3C_{12}H_6+C_{36}H_{12}.$$

In this case phenyl, $C_{12}H_4(C_{12}H_6)$, separates into benzol and phenylene, which last is then converted into its polymer chrysen, $C_{36}H_{12}=(C_{12}H_4)_3$. —*Comptes Rendus*, lxiii, 788, 834. W. G.

3. *On the acids of the lactic series.*—By the action of metallic zinc upon a mixture of iodid of amyl and oxalate of ethyl, FRANKLAND and DUPPA have obtained the ethers of several new acids belonging to the lactic series. The ether with the lowest boiling point, 203° C., has the formula $\text{Є}_9H_{18}\Theta_3$. The authors assign to it the rational formula

$$^{*}\left\{\begin{array}{l}\text{ЄAmHHo}\\ \text{Є}\Theta\text{Eto}\end{array}\right.$$

calling it amyl-hydroxalate of ethyl and regarding it as oxalate of ethyl in which one atom of oxygen is replaced by one of amyl and one of hydrogen. This body may be compared with lactate of ethyl from which it may be theoretically derived by replacing an atom of methyl by an atom of amyl.

$$\left\{\begin{array}{l}\text{ЄMeHHo}\\ \text{Є}\Theta\text{Eto}\end{array}\right. \qquad\qquad \left\{\begin{array}{l}\text{ЄAmH, Ho}\\ \text{Є}\Theta\text{Eto}\end{array}\right.$$

Lactate of ethyl. Amyl hydrate of ethyl.

The new ether is a rather oily, transparent, faintly straw-yellow liquid of density 0·9449 at 13° C., with an agreeable odor and burning taste.

A second ether formed at the same time has the formula $\left\{\begin{array}{l}\text{ЄAmHEto}\\ \text{Є}\Theta\text{Eto}\end{array}\right.$. The authors term it ethylated amyl-hydroxalate of ethyl. Its density is 0·9399 at 13° C.; it boils at 224°–225°, is faint yellow, and oily with an aromatic somewhat amylic odor and burning taste.

A third ether has the formula

$$\left\{\begin{array}{l}\text{ЄAm}_2\text{Ho}\\ \text{Є}\Theta\text{Eto}\end{array}\right.$$

The authors term this liquid diamyloxalate of ethyl; it closely resembles these last mentioned in appearance and properties. From the ethers the authors have also prepared the corresponding acids, for the description of which, however, we must refer to the original paper.

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* Am=Є_5H_{11}, Et=Є_2H_5, Ho=$(H\Theta)$, Eto=$C_2H_5\Theta$), &c.

The action of zinc upon a mixture of iodid of ethyl and oxalate of amyl gives rise to a new ether which the authors term diethoxalate of amyl and which has the formula $\left\{\begin{array}{l}\text{ȻEt}_2\text{Ho}\\ \text{ȻΘAmo}\end{array}\right.$. It is colorless and oily with an agreeable somewhat amylic odor and boils at 225° C. It will be readily seen that this ether is isomeric with ethylated amyl-hydroxalates of ethyl. By the action of zinc upon a mixture of iodid of amyl and oxalate of amyl the authors obtained two ethers, the first of which has the formula $\left\{\begin{array}{l}\text{ȻAm}_2\text{Ho}\\ \text{ȻΘAmo}\end{array}\right.$ and may be termed diamyloxalate of amyl, while the second had the formula and properties of capronic ether $\left\{\begin{array}{l}\text{ȻBuH}_2\\ \text{ȻΘAgo}\end{array}\right.$. In conclusion the authors give an elaborate and extremely interesting discussion of the classification and theory of the acids of the lactic series, for which however we must refer to the original. The following summary of their results is in their own language.

(1.) All the acids of the lactic series are essentially monobasic.

(2.) These acids are of four kinds, namely, normal, secondary, normal olefine acids and secondary olefine acids; and each of these has its own series of etheric acids in which the hydrogen of the hydroxyl contained in the positive or basylous constituent of the acid is replaced by a positive or negative compound radical.

(3.) The normal acids are derived from oxalic acid by the replacement of one atom of oxygen either by two atoms of hydrogen, or by one atom of hydrogen and one atom of an alcohol radical.

(4.) The secondary acids are derived from oxalic acid by the replacement of one atom of oxygen by two atoms of monovalent alcoholic radicals.

(5.) The olefine acids are derived from oxalic acid by a similar substitution of two positive monovalent radicals in place of one atom of oxygen with the simultaneous insertion of an olefine hydrocarbon or divalent radical $\text{Ȼ}_n\text{H}_{2n}$ between the two atoms of oxatyl.

(6.) The acids of the lactic series stand to the acids of the acetic series in the very simple relation just pointed out by Kolbe; namely, that if in any acid of the lactic series, the hydroxyl, ethoxyl, etc., in the positive radical is replaced by hydrogen this acid is converted into a member of the acetic series.

(7.) The acids of the lactic series stand in an almost equally simple relation to the acids of the acrylic series as appears from a comparison of the following formulas: $\underbrace{\left\{\begin{array}{l}\text{Ȼ(ȻH}_3\text{)HHo}\\ \text{ȻΘHo}\end{array}\right.}_{\text{Lactic acid.}}$ $\left\{\begin{array}{l}\text{Ȼ(ȻH}_2\text{)}''\text{H}\\ \text{ȻΘHo}\end{array}\right.$.

—*Ann. der Chemie und Pharmacie*, cxlii, 1. W. G.

4. *Thallic acid.*—E. CARSTANJEN states that when thallic oxyd, precipitated from the chlorid of ammonia, is suspended in a strong solution of potash, gently heated, and a quick current of chlorine gas passed through the liquid, it becomes of an intense violet red color, and contains potassic thallate. It may be evaporated, and even filtered through paper, but is decomposed by acids, evolving oxygen. The author is still at work upon this interesting compound.—*J. pr. Ch.*, ci, 55, June, 1867.

5. *The new Chemical Calculus.*—On the 3d of May, 1866, Sir Benjamin Brodie, Professor of Chemistry in the University of Oxford, read a paper before the Royal Society, entitled "The Calculus of Chemical operations; being a method for the investigation by means of symbols, of the laws of the distribution of weight in chemical change; Part I. On the construction of Chemical Symbols." This paper was published in the Philosophical Transactions for 1866, part II, 856, and, in abstract, in the Philosophical Magazine, IV, xxxii, 227. On the 6th of June, 1867, Prof. Brodie delivered a lecture before the Chemical Society, "On the mode of representation afforded by the chemical calculus, as contrasted with the atomic theory," which was quite fully reported in the "Chemical News" of June 14, and the "Laboratory" of the 15th, together with the subsequent discussions by Professors Frankland, Williamson, Odling, Foster, Wanklyn, Maxwell, etc. Of the critical articles called forth by Sir Benjamin Brodie's communications, those of Williamson, Chem. News, xvi, 3, July 5; of Wanklyn and Davey, Phil. Mag., IV, xxxiv, 26, July, 1867; of Kekulé, The Laboratory, i, 303, July 27; and of A. Crum Brown, Phil. Mag., IV, xxxiv, 129, August, may be mentioned. The views of Prof. Kekulé, contained in the first of a series of papers on Theoretical Chemistry, contributed to that valuable little journal, are stated so clearly, and at the same time are so just, that we reproduce the article entire. It should be remarked, however, that Professor Brodie's "Ideal Chemistry" is to be comprised in three papers, the 1st being on "The construction of chemical symbols;" the 2nd on "The theory of chemical equations;" and the 3d on "The principles of symbolic classification." Only the first of these has yet appeared. G. F. B.

On the existence of Chemical atoms; by Aug. Kekulé.

The question whether atoms exist or not has but little significance in a chemical point of view; its discussion belongs rather to metaphysics. In chemistry we have only to decide whether the assumption of atoms is an hypothesis adapted to the explanation of chemical phenomena. More especially have we to consider the question, whether a further development of the atomic hypothesis promises to advance our knowledge of the mechanism of chemical phenomena.

I have no hesitation in saying that, from a philosophical point of view, I do not believe in the actual existence of atoms, taking the word in its literal signification of indivisible particles of matter. I rather expect that we shall some day find, for what we now call atoms, a mathematico-mechanical explanation, which will render an account of atomic weight, of atomicity, and of numerous other properties of the so-called atoms. As a chemist, however, I regard the assumption of atoms, not only as advisable, but as absolutely necessary in chemistry. I will even go further, and declare my belief that *chemical atoms exist*, provided the term be understood to denote those particles of matter which undergo no further division in chemical metamorphoses. Should the progress of science lead to a theory of the constitution of chemical atoms—important as such a knowledge might be for the general philosophy of matter—it would make but little alteration in chemistry itself. The chemical atom will always remain the chemical unit; and for specially chemical considerations we may always start from the constitution of atoms, and avail ourselves of the simplified expression thus obtained, that is to say, of the atomic hypothesis. We may, in fact, adopt the view of Dumas and of Faraday, "that whether matter be atomic or not, thus much is certain, that granting it to be atomic, it would appear as it now does."

After these remarks, it is scarcely necessary to say that I set but small value on most of the attacks recently made against the atomic hypothesis. In many of them I see merely words and phrases, not ideas. It is, however, quite otherwise with the endeavors of those who seek to discover chemical laws independently of the atomic hypothesis. All endeavors of this kind possess great merit; and if they lead to actual results, the laws thus discovered independently of the atomic hypothesis, will be reducible to that hypothesis, and will follow as consequences from it, always supposing that the atomic hypothesis itself is true.

Brodie's 'Calculus of Chemical Operations' is an attempt of this kind. But the talented author of these speculations evidently goes too far, when he declares "that Dalton's theory is inadequate for present purposes, and that it could no longer be advantageously used to elucidate the work carried on by chemists;" and when he adds "that chemistry had got on the wrong track—off the rails, in fact."

A final verdict on these speculations cannot at present be pronounced, seeing that we have before us merely the method of drawing conclusions, and the application of this method to the construction of formulæ for the elements and for particular compounds. The author promises, indeed, that his method will present numerous and important advantages, and he hopes, further, "to be able to express, by formulæ, dynamical facts;" but all these points are reserved for future communications. We may, however, even now assert that the published results, and especially the formulæ given for the elements and compounds, possess no advantage whatever over the views now universally received. They contain, like those hitherto in use, only statics, and no dynamics, and although we are assured "that they express by symbols, the exact facts of chemistry," it is impossible not to perceive that these symbols involve an almost unlimited number of hypotheses for which there is no proof whatever.

For the elements, Brodie, as is well known, comes to the conclusion that there exist three groups, expressible by the symbols—

$$x \qquad y^2 \qquad x+y^2.$$

All elements belonging to the third group (chlorine, bromine, iodine, nitrogen, etc.) are regarded as compounds. They are not, indeed, supposed to contain two kinds of matter at present unknown in the separate state; but the much less admissible hypothesis is made that they consist of a constituent hitherto unknown in the isolated state, combined with *hydrogen.*

Such an assumption is so directly at variance, not only with all views hitherto received, but with the entire range of known facts, that it requires to be tested with all possible circumspection.

Even admitting at the outset that Brodie's speculation is founded "on a very fair amount of hypothesis," we cannot avoid seeing at the first glance that it leads to hypotheses of most astounding character, and on closer examination we are inevitably led to the conclusion that the entire speculation is based on pure caprice. Its foundation involves especially the three following hypotheses:

(1) Hydrogen must be assumed as the starting point.
(2) Hydrogen is an element.
(3) Hydrogen is the result of a single operation, therefore $= \alpha$.

With regard to the first, it must, at all events, be admitted that, instead of hydrogen, any other element ought to be admissible as the starting-point of the system. But if chlorine ($= \chi$) or nitrogen ($= \nu$) had been selected for this purpose, no calculation could have led to the conclusion that these bodies contain hydrogen. Now, it is clear that a system of symbols cannot be admitted as a true representation of actual facts, unless its results are independent of the particular member of the system which has been taken as a starting-point for the construction of the whole.

The second hypothesis, that hydrogen is an element, might have been admitted without remark by every chemist who regards as elements all bodies not hitherto decomposed; but the author of the speculations now under consideration is under an obligation to show grounds for such an assumption, inasmuch as he comes to the conclusion that others of the so-called elements are compounds.

The third point, and perhaps the most important in connection with results, is no less hypothetical. Why is hydrogen regarded as the result of a single operation, and not as the result of two, seeing that oxygen, sulphur, etc., are supposed to result from two operations? We are assured, "There were strong reasons for preferring the use of the system in which α was employed to present the standard amount of matter;" but these reasons are not yet made known, and therefore their value cannot be appreciated. So much, however, is certain, that, if instead of α, the expression α^2 had been chosen for the purpose just mentioned, Brodie's own form of reasoning would have led to formulæ identical in every particular with those now in use. All bodies which we now regard as elements would, or, at least, might have been found to be such; and for all compounds, the system in question would have led to the very formulæ which have long been used by the adherents of the atomic molecular theory.

The hypothesis, hydrogen $= \alpha$, is said to be the simplest that could be adopted; but it may be laid down as a general rule that, in selecting from a number of different hypotheses the one which is most probable on the ground of simplicity, it is necessary to look, not only to the relative simplicity of the hypothesis itself, but to the more or less simple character of the consequences which follow from it.

Had the author of the "Calculus of Chemical Operations" merely expressed an opinion that the formulæ which he has constructed for elements and compounds are "one of the different expressions" which, according to the principle of prime factors, are deducible from the known facts connected with relations of volume, everybody would have agreed with him. We should have perceived (though, perhaps, with some surprise) that our existing hypotheses are not the only ones capable of accounting for these relations of volume; and we should have been strengthened in the conviction that the correctness of our present theories and formulæ does not depend for its proof on volume-relations alone. But the author of this new mode of representation goes further. Among other things he plainly puts forward the view that many of the substances now regarded as elements contain hydrogen; and suggests that, even if the elements which are combined with hydrogen in these compounds do not exist in the free state on our earth, they may possibly exist in that state in other parts of the universe.

No one will maintain that the bodies which we now call elements are necessarily and absolutely undecomposable. But if, on the other hand, it be asserted that our existing elements are actually of compound nature, the establishment of such a proposition will certainly require more than the simple observation, that a result of the kind may possibly be deduced from a kind of reasoning founded upon hypothesis. We shall, at least, require proof that such an assumption is calculated to lead to useful results, and that it presents decided advantages over our present views. If it be maintained that many of the substances now regarded as elementary contain a substance at present unknown in the free state, combined with another body—hydrogen, for example—which we do not know in that state, we may, certainly, require the assertion to be proved by the actual separation of hydrogen from these substances. In default, however, of further knowledge, we may hold fast by the principle announced by Dalton, "that a substance, till it is decomposed, must be regarded, according to the just logic of chemistry, as an elementary substance."

II. MINERALOGY AND GEOLOGY.

1. *Notice of volume IV of the Paleontology of New York, by the Author.* 24 pp., 8vo. Albany, March, 1867.—Owing to the length of time required to complete the numerous plates of the fourth volume of his great work on the Paleontology of New York, Professor Hall has here given in advance a brief statement of the contents of this volume sometime since printed. The third volume, the text of which appeared in 1861, comprises the fossils of the Lower Helderberg and the Oriskany sandstone; and it is an exceedingly rich volume in its contents, its plates numbering nearly 140, and including a great variety of species among Crinoids, Brachiopods, Acephals, Gasteropods, Orthocerata, Trilobites and Eurypterids, all evincing a vast amount of careful research. The *fourth* volume, as the "Notice" states, takes up the following formations of the Devonian, the Upper Helderberg, Hamilton, Portage and Chemung, and as the number of species in these rocks is very great, Professor Hall confines himself here to the *Brachiopods*, deferring to a future volume the remainder of the species. We take the following facts from this Notice.

The order adopted, and the list of genera under which the species are described or discussed, are as follows:—Lingula, Discina, Crania, Pholidops (=Pseudocrania), Orthis, Streptorhynchus, Strophomena, Strophodonta, Chonetes, Productus, Strophalosia and Productella, Spirifera, Cyrtina and Cyrtia, Trematospira, Rhynchospira, Nucleospira, Retzia, Athyris, Meristella and Meristina, Pentagonia, Atrypa, Cœlospira, Rhynchonella =Stenocisma, Leiorhynchus, Leptocœlia, Camarophoria, Pentamerus, Stricklandinia, Pentamerella, Gypidula, Amphigenia and Rensselæria, Terebratula, Cryptonella, Centronella, Tropidoleptus, Vitulina.

The Lingulæ of the Upper Helderberg are *L. ceryx, desiderata, Manni;* of the Hamilton group, *L. exilis, ligea, ligea* var., *palæformis, leana* (n. s.), *maida* (n. s.), *punctata* (n. s.), *nuda* (n. s.), *densa* (n. s.), *delia* (n. s.), *alveata* (n. s.), *spatulata;* of the Chemung group, *L. melia* (n.s.), *Cuyahoga* (n.s.).

The Discinæ of the Hamilton group are, *Discina minuta, humilis* (n. s.), *grandis, Randalli* (n. s.), *Doria* (n. s.), *seneca* (n. s.), *media* (n. s.), *Tullia* (n. s.), *Lodensis, truncata;* of the Chemung group, *Discina neglecta* (n. s.), *D. Elmira* (n. s.), *Alleghania, Newberryi* (n. s.).

Of the genus Crania, the *C. Aurora* (n. s.), occurs in the Schoharie grit; in the Hamilton, are *C. Hamiltonæ, crenistriata*, and *gregaria*, or the young of *C. Hamilitonæ;* in the Chemung, *C. Leoni.*

Of the genus Pholidops, two species, *P. areolata* (n. s.), and *P. Hamiltonæ*, occur in the Hamilton group.

The species of Orthis, of the Upper Helderberg are, *O. peloris* (n. s), *lenticularis, alsus* (n. s.), *mitis* (n. s.), *livia, similis* (n. s.), *cleobis* (n. s.), *idas* (n. s.), *propinqua;* of the Hamilton, *Orthis solitaria, lepida, Vanuxemi, leucosia, Penelope, cyclas, idoneus* (n. s.), *Tulliensis;* of the Portage and Chemung groups, *O. carinata, Tioya* (n. s.), *impressa, Leonensis* (n. s.), *Thiemei*, and *leucosia?*

Under the genus Streptorhynchus, several species heretofore described are referred to *Strophomena* (*Streptorhynchus*) *Chemungensis* Conrad, under which, as varieties, are arranged *Strophomena bifurcata, S. arctostriata, S. pectinacea*, and *Orthis perversa* (Hall); *Streptorhynchus pandora* (Billings); *Orthisina arctostriata* and *O. alternata* (Hall); *Orthis inequalis* and *O. pravus* (Hall, Iowa Report). The species is extremely variable, having a great vertical and horizontal distribution, and appears under many phases.

The *Strophomena rhomboidalis* (Wahlenberg)=*S. rugosa* (Rafinesque) occurs in the Schoharie grit, and is abundant in the Corniferous limestone, but is unknown in the Hamilton and Chemung groups.

The genus Stropodonta extends throughout the series; and two species, the *S. demissa* and *S. perplana*, are found from the Schoharie grit to the Chemung group inclusive. The species recognized in the Upper Helderberg group are, *S. demissa, perplana, alveata, callosa, parva, crebristriata, inequiradiata, Patersoni, hemispherica, inequistriata, ampla;* in the Hamilton group, *S. concava, perplana* Conrad (which has been described under the names *Strophomena perplana, S. pluristriata* and *S. delthyris* Conrad; and as *S. nerovsa, S. crenistriata* and *S. fragilis* Hall); *demissa, nacrea, inequistriata, jumia;* in the Chemung, *S. Cayuta* (n. s.), *mucronata, cælata* (n. s.), *perplana* var. *nervosa, demissa.*

In the genus Chonetes, we find verified in a very satisfactory manner the observations made by Count von Keyserling, in regard to the direction of the tubes or spine-bases in the area of the ventral valve. These tubes are directed from the hinge-line toward the apex of the valve, and parallel to the sides of the triangular fissure. They appear on the crest of the area as little pustules or elongated tubular spines, which may be either vertical to the hinge-line or directed outward. The species of the Upper Helderberg and Hamilton groups are, *C. hemispherica, arcuata, acutiradiata, lineata, Yandellana, mucronata, deflecta, pusilla, setigera, scitula, lepida, coronata, Logani.*

The occurrence of the *C. Logani* in the Tully limestone carries back the appearance of this species to a much earlier epoch than had heretofore been known. The species is not known in the Chemung group within the State; though found in the sandstones of the same age in Ohio, and in the beds at the base of the Burlington limestone in Iowa and Illinois.

In the Chemung group we have the recurrence of *Chonetes scitula, C. lepida* and *C. setigera ;* with a new and remarkable species, the *C. muricata*, which has the apex truncated and the surface of the ventral valve ornamented with spines, but having the vascular markings peculiar to the genus.

Under the head of Productus and Strophalosia, the relations of these genera and of the genus Aulosteges are discussed. The Devonian species, sometimes referred to Strophalosia, are shown to have a narrow area, but with internal vascular impressions like Productus. The absence of an area in the genus Productus is not uniform, as is shown in *P. costatus* of the Carboniferous system in America ; and the same has been shown by Mr. Davidson to be true of *P. sinuatus* and *P. semireticulatus* of Europe.

In comparing the American Devonian forms of Productidæ with the Strophalosia of the Permian system, the former have a greater width on the hinge-line, and in this respect more resemble typical Productus; while the narrow cardinal area and hinge-teeth assimilate them with Strophalosia. Notwithstanding this feature, the vascular markings are like Productus. At this epoch we have the earliest known appearance of these forms, the type of which becomes extravagantly developed in the Carboniferous period, and, waning during the Permian epoch, is presented for the most part in degenerate modifications of the typical forms. Although we cannot shut our eyes to this fact of development to what may be termed the perfection of the type, and its more abrupt decline, we are either compelled to extend the characters of Productus so as to cover the two forms or modifications indicated, or else to propose a distinct designation. The latter course has been adopted, and the name Productella is proposed for the strophaloid Productids of the Devonian period.

The subgenus Productella is compared as follows, in Pal. N. Y., vol. IV, page 153 : "These shells differ from Strophalosia in the extremely narrow linear cardinal area, greater extension of the hinge-line, more extreme arcuation or ventricosity of the ventral valve in many or most of the species, and especially in the direction and termination of the reniform vascular impressions, which resemble those of Aulosteges and of some species of Productus. It differs from Productus in the constant presence of an area, hinge-teeth and sockets."

The Productellæ of the Upper Helderberg and Hamilton groups mentioned are, *P. subaculeata, navicella, Shumardiana, spinulicosta, truncata, dumosa, exanthemata, Tullia* (n. s.), *subalata ;* of the Chemung group, *P. hirsuta, hirsuta* var. *rectispina, Boydii, rarispina, lachrymosa, lachrymosa* var. *linea, lachrymosa* var. *stigmata, speciosa, striatulata* (n. s.), *hystriculata*, (n. s.), *costatula* (n. s.), *costatula* var. *strigata, arctirostrata, bialveata* (n. s.), *onusta* (n. s.).

So great a number of fossils of this type in many localities, and particulary in the western part of the State, give a Carboniferous aspect to the strata; and leaving out a few forms which gradually disappear in the western extension of the formation, the paleozoic evidence might be regarded as decidedly favoring this view. The distinction, however, between Devonian and Carboniferous faunas is based as often upon geographical as chronological relations.

The species of Spirifera in the Upper Helderberg group are, *S. duodenaria*, *macra*, *raricosta* and *Grieri*, occurring both in the Schoharie grit and in the limestone above; which latter likewise contains the following species: *S. gregaria*, *Oweni*, *acuminata*, *macrothyris*, *unica* (n. s.), *disparilis*, *varicosa*, *varicosa* var., *segmenta*, *arctisegmenta*, *euruteines*, *euruteines* var. *fornacula*, *Mannii*, *divaricata*. *fimbriata*. The last named species occurs also in the Oriskany sandstone and Schoharie grit. Several of the species indicated above are known in their perfect condition only in the limestones of this age in Ohio and adjacent States of Indiana and Kentucky.

In the Hamilton group, the most abundant and widely distributed species is *Spirifera mucronata*, besides there are, *Spirifera Tullia* (n. s.), *formosa*, *sculptilis*, *ziczac*, *granulifera*, *Marcyi*, *medialis*, *medialis* var. *Eatoni*, *angusta*, *macronota*, *subumbona*; in the Portage group only the *Spirifera lœvis*, which has much the general aspect of a Carboniferous form; in the Chemung, *S. mesacostalis*, *mesastrialis*, *disjuncta*, with its numerous synonyms and the species represented in a great variety of aspects, *alta* (n. s.), *prœmatura* (n. s.).

The chapter on Spirifera is concluded with some remarks upon the geological and geographical distribution of the species of Spirifers, the hinge-structure, etc., which have already been published.*

The name Ambocœlia is continued, being regarded as presenting sufficient distinction from Spirifera; and in the Hamilton group are recognized, *Ambocœlia umbonata*, *A. preumbona*, in the Chemung group, *A. umbonata* var. *gregaria*.

On page 263 of the volume are some observations on the genus Cyrtia of Dalman, and Cyrtina of Davidson. So long since as in 1858, Mr. Davidson, in his Introduction to the Study of the Brachiopoda, had expressed some doubts as to the value of the genus Cyrtia of Dalman; and later investigation had shown that the typical species of that genus does not differ from Spirifera. At the same time, some forms usually referred to the genus Cyrtia possess a peculiar modification of the dental plates, with a largely developed median septum and punctate structure of the shell. For these forms, Mr. Davidson has proposed the name Cyrtina. All the American species heretofore referred to Cyrtia, and which have been reëxamined, prove to belong to Cyrtina. Of these we have *C. pyramidalis* in the Niagara group, *C. Dalmani* in the Lower Helderberg group, and *C. rostrata* in the Oriskany sandstone.

Three species are described in the present volume from the rocks of New York, viz: *Cyrtina biplicata*, from the Schoharie grit; *crassa* (n. s.),

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* The paper by Professor Hall alluded to on page 408 of vol. xliii of this Journal, was not a newly written article as might be inferred from the note, but as he states in introducing it, a citation from the pages of his volume IV.

from the Corniferous limestone; *Hamiltoniæ*, from the Hamilton group; and a variety of the latter from the Chemung group. A species from the Hamilton group in Iowa, *C. curvilineata* (?), is noticed.

The genus Trematospira, proposed in vol. iii, and published in the Tenth Report on the State Cabinet, is represented in the Hamilton group by two species: *T. gibbosa*, *hirsuta*.

The genus Rhynchospira is represented only by a single species, the *R. lepida*. The *R. nobilis* from the Hamilton group, formerly referred to this genus, presents some points which render its generic relations more nearly with Trematospira.

The genus Nucleospira is represented by a single species, the *N. concinna.*

Under Athyris we have the *Athyris spiriferoides*, an abundant and widely distributed form in the Hamilton group; and the *Athyris vittata*, occurring in the limestone of the Upper Helderberg group; and also in the Hamilton group of Iowa. A second species in the Hamilton group is the *Athyris cora.* In the Chemung group, we have the *Athyris angelica* and the *A. ? polita.*

The genus Meristella, separated from Athyris on account of its different external characters and muscular impressions, is represented by *M. nasuta*, *scitula*, *Doris*, *Barrisi*, *Haskinsi*, *rostrata*, *Meta* (n. s.). In the Chemung group, there are a few casts of an undetermined species. The *Meristella unisulcata* of the Corniferous limestone is referred to the subgenus? Pentagonia of Cozzens, and its varieties of form illustrated. The species is of rare occurrence in the Hamilton group.

The genus Atrypa, as applied to forms strictly congeneric with *Atrypa reticularis*, embraces but few species, and these are regarded by some paleontologists as merely varieties of still fewer species. In this volume, the *Atrypa impressa* of the Schoharie grit is continued as a distinct species; although resembling the *A. reticularis* in general features, it presents a wide departure from the forms of that type in other strata; and if we are to regard these varieties as due to physical causes, the nature of the sediments, etc., then there is reason to believe that in other instances the same physical influences have produced changes which are recognized without hesitation as of specific value. The *Atrypa reticularis* in its various phases, occurs in the Corniferous limestone, the Hamilton and Chemung groups. The *Atrypa spinosa* (Hall), or *Atrypa aspera* (Schlotheim), is recognized as a very distinct and well-marked species, occurring in the Corniferous limestone, Hamilton and Chemung groups. In the Hamilton group it is more abundant and better preserved than in any other formation; and occurring in the same beds with *A. reticularis*, it never approaches that one in character; there is no difficulty in distinguishing the one from the other; and the same is true of these forms in the Chemung group. It is also observed that the same distinction between these species exists in Illinois and Iowa. The *Atrypa hystrix* of the Chemung group is likewise regarded as a distinct species, though possessing many features of an extravagant *A. spinosa*. A species of Atrypa, closely resembling the *Atrypa marginalis* of Dalman, occurs in the Corniferous limestone. This species, *Atrypa pseudomarginalis*, is of rare occurence in the rocks of New York.

A single Cœlospira occurs in the Corniferous limestone, which, so far as known, possesses no characters differing from *Cœleospira concava* of the Lower Helderberg group.

Under the Family Rhynchonellidæ, the species usually referred to the genus Rhynchonella are shown to differ from recent species referred to that genus; while at the same time the internal structure and appendages of the typical species of the genus (*R. loxia*) remain unknown or unillustrated. Under these circumstances, the name Stenocisma, proposed by Mr. Conrad in 1841, is revived, and applied to most of the rhynchonelloid forms of the rocks under consideration. Since, however, Rhynchonella has come to be so well known, and many of the species have been described under the generic designation, the name is still retained. The species of the Corniferous limestone are, *Rhynchonella* (*Stenocisma*) *Tethys*, *Billingsi* (in place of *R. thalia* of Billings, name preoccupied) *Carolina* (n. s.), *Royana* (n. s.); of the Hamilton group, *R.* (*Stenocisma*) *Horsfordi*, *Sappho*, *congregata*, *prolifica* (n. s.), *dotis* (n. s.), *carica* (n. s.); of the Chemung group, the following species are described: *Rhynchonella* (*Stenocisma*) *eximia*, *Stephani* (n. s.), *duplicata*, *contracta*, *orbicularis*, *Sappho* var.

The genus Leiorhynchus is retained for such forms as *L. limitaris* and *L. quadricostata* which present, among other distinguishing features, a division or bifurcation of the plications on the mesial fold and sinus. The species recognized as belonging to this genus are *L. limitaris*, *L. mysia* (n. s.), *L. quadricostata*, *L. multicosta*, *L. iris* (n. s.), *L. Kelloggi* (n. s.), *L. sinuatus* (n. s.), *L. mesacostalis*, *L. globuliformis*, *L. dubius* (n. s.).

Under the genus Leptocœlia, the *L. acutiplicata* is the only species recognized.

The genus Camarophoria has been observed in a single smooth species, the *C. eucharis*, from the Upper Helderberg limestones.

Some of the pentameroid forms, heretofore referred to the genus Pentamerus, are placed under new genera, on account of certain peculiarities of their internal structure.

Pentamerella includes *P. arata* (=*Pentamerus aratus*), *P. papilionensis* (=*Pentamerus papilionensis*), *P. micula* (n. s.), *P. obsolescens* (n. s.), and *P. dubia* (=*Spirifer dubius* Hall, Thirteenth Report on the State Cabinet); Gypidula includes *G. occidentalis* (=*Pentamerus occidentalis* Hall, Geol. Report of Iowa), and *G. læviuscula* (n. s.); Amphigenia is proposed to include the original *Pentamerus elongatus* of Vanuxem, which possesses characters unlike any other genus of the pentameroid family; the *A. elongata*, and a variety *undulata*. The species formerly described as *subtrigonalis* appears to be only a variety of the *A. elongata*. Rensselæria is recognized with doubt, and a single species, *R.* ? *Johanni*, is noticed from the rocks of the age of the Upper Helderberg group in Iowa. The genus Terebratula is recognized in the following species: *T. Lens*, *T. Sullivanti* (n. s.), *T. harmonia* (n. s.), *T. Rœmingeri*, *T. Elia* (n. s.), *T. jucunda* (n. s.), *T. navicella* (n. s.), *T. simulator* (n. s.).

The genus Cryptonella includes *Cryptonella rectirostra*, *C. planirostra*, *C. Iphis* (n. s.), *C. Lincklœni*, and a doubtful form, *Cryptonella* (*Terebratula*) *eudora*, from the Chemung group; and Centronella, the *C. glansfagea*, *C. alveata*, *C. impressa* and *C. glaucia* (n. s.).

A further study of the genus Tropidoleptus has revealed certain features of internal structure, which seem to ally it with the Terebratulidæ. The *T. carinatus* is the typical species of the genus. A western form has been described under the name *T. occidens.*

The relations of the genus Vitulina are not fully established. The shell-structure is punctate, with a papillose surface, a high area on the ventral valve, with a large triangular fissure. The genus embraces a single species, the *Vitulina pustulosa.*

The volume contains critical remarks on many of the various genera, citations from some of which, Professor Hall gives in the Notice of the volume.

The labors of Professor Hall are contributing very largely to the progress of American and general Geology and Paleontology, and it is to be hoped that his engravers will do their work as rapidly as is consistent with its accuracy and beauty, that the world may speedily reap the full benefit of his extended researches.

2. *On the Paleontology of Victoria, South Australia;* by FREDERICK McCOY.—The author, after treating of the distribution and characteristics of the Post-tertiary, Tertiary, Cretaceous, and Triassic of Victoria, and pronouncing the Australian coal beds Mesozoic, makes the following observations on the Paleozoic formations of the country.

Carboniferous.—The sandstones of the Avon in Gippsland are the only traces of this formation that I can recognize in Victoria, and the only fossil I have seen from it is the *Lepidodendron*, referred to above, identical with that recognized by me many years ago from New South Wales, and which I have lately seen also from Queensland.

Devonian.—It is with great pleasure I announce the fact of my having been able satisfactorily to determine the existence of this formation also in Australia, the limestone of Buchan in Gippsland containing characteristic corals, Placodermatus fish, and abundance of the *Spirifera lævicostata*, perfectly identical with specimens from the European Devonian limestones of the Eisel.

Upper Silurian.—I have been able to recognise the Mayhill sandstones and the Wenlock rocks with certainty in many localities in Victoria. At Broadhurst Creek, for instance, the beds are filled with numbers of the *Phacops* (*Odontochilæ*) *longicaudatus* exactly as the corresponding English beds of Cheny Longville are in Shropshire; and here, as in every part of the northern hemisphere, the *Spirigera reticulata* is the commonest Brachiopod, and many others identical with species of England, Bohemia, and North America occur with it.

The Ludlow rocks are indicated by the *Orthoceras bullatum*, and a series of starfish closely representing those of the English Ludlow beds, together with a beautiful new *Homalonotus* (*H. Harrisoni* M'Coy), which I have named after the discoverer, as well as the *Graptolites Ludensis.* The *Hemithyris diodonta* Dal. is as abundant in the Mayhill sandstone of Victoria as in the corresponding English beds at Malvern, and the same appearance of oblong smooth *Pentamerus* (*P. Australis* M'Coy) mark this sandy base of the Upper Silurian in Victoria as in England and Wales, and North America.

Cambrian of Sedgwick, Lower Silurian of Murchison.—It is to this period that I have been able without hesitation to refer the whole of the slates containing gold-quartz veins or reefs in Victoria, and all the slates containing these gold-bearing veins are identical in age and character with those of North Wales, in which the Romans worked the gold mines of Gogo Fau.

Not only are the majority of the fossil *Graptolites* found in the Welsh Llandeilo Flag, and of the corresponding Cumberland and Scotch slates, also found in those beds in Victoria, but we have in these formations the most extraordinary proof of the unexpected fact which I announced on a former occasion, that there was in the Cambrian or Lower Silurian period a nearly complete specific uniformity of the marine fauna, not only over the whole northern hemisphere, but across the tropics, extending to this remote temperate latitude of the southern hemisphere.

In the slates of the goldfields the principal fossils are *Graptolites*, and, what is very extraordinary, I have here identified specifically nearly the whole of the series of remarkable compound *Graptolites* first made known from the similar slates of Canada by the researches of Professor Hall. Many of the species have not yet been recognised in any but the Canadian localities in the northern hemisphere, and to find nearly the whole series here is most interesting, as their powers of locomotion could only be exercised in the short ovarian and free stage, so that, except on the supposition of a uniform marine fauna at this earliest zoological period of the earth's history, we could scarcely account for this width of distribution, and still less so of the littoral or shallow-water mollusca which accompany them in other beds. The *Diplograpsus mucronatus* Hall, so common in the Utica slates of New York, I find in equal abundance here in the slates of Bendigo or Sandhurst, and with it abundance of the *D. quadrangularis* M'Coy, completely identical with those I described many years ago from the slates of Dumfriesshire. The *Diplograpsus pristis* (His. sp.), also occurs in these same slates, mixed with the others, as in Sweden, Bohemia, and Scotland, but in certain different sandy beds it covers the whole of the planes of deposition in millions, to the exclusion of everything else, exactly as it does in certain beds of the English Caradoc sandstone near Church Stretton. In some localities these are replaced by great numbers of the Bohemian *Diplograpsus palmeus* Barrande, on the upper end of many specimens of which I find a large smooth pear-shaped or heart-shaped appendage, which I believe to be an ovarian vesicle. I should remark that I have observed exactly the same appendage (bearing out, I think, the idea which I have supported formerly on other grounds,* of the affinity of the *Graptolites* with the *Hydroida*) in specimens of this species from the slates of the typical locality in Bohemia, when carrying out the direct careful comparisons of specimens of species, which I state to be identical in Victoria and other countries; so the frequent observation of this apparent ovicell in the Victorian specimens does not at all affect the identity of this species with that of the basin of Bohemia, of which there can be no doubt. The *D. ramosus* Hall is also in our slates identical with those of the Utica slate of New York. Of the group of compound Canadian *Graptolites*, the commonest in the Victorian goldfield slates of many localities is the

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* British Palæozoic Rocks and Fossils.

Didymograpsus caduceus Salt., first described from the Quebec slates. In many localities the specimens of this species are as small as the first described Canadian ones, but in others they acquire a greatly increased size, occasionally twice the length and nearly three times the width, and the angle of divarication of the two branches varies from 5° to 70°.

This is usually accompanied by the *D. serratulus* Hall, identical with those of New York slates, and generally also by the very large Canadian *D. bryonoides* Hall, which it is possible may be hereafter found to be the perfect development of my *G. latus.* The *D. nitidus* Hall is more rare, but perfectly identical with the Canadian types. The *Graptolites gracilis* Hall, identical with the New York and Canadian species, is one of the rare compound forms. The curious radiating compound forms, which created so much astonishment when published first by Professor Hall in his Decades of the paleontology of this part of Sir H. Logan's geological survey of Canada, I find in just as great abundance in the slates of the same age in Victoria. *D. octobrachiatus*, *D. quadribrachiatus*, and *D. Logani* Hall, are, especially the latter, not uncommon in many of the goldfield localities. The curious Canadian quadrifid graptolite, named *Phyllograptus Typus* by Hall, is one of our most abundant Australian Graptolites; but, although sometimes upwards of an inch in length, small specimens, I find, on comparison with Swedish specimens of the *G. Folium* of Hisinger, are perfectly identical therewith; and further, on carefully comparing Bohemian specimens of the *G. ovatus* of Barrande with the Swedish *G. folium*, I have no doubt they belong to one variable species, and are identical with the smaller examples of the Australian and Canadian species; and further, that the European specimens are truly quadrifoliate, like Hall's *Phyllograptus;* and in this way the difference in the different descriptions, as to the width of the midrib, becomes intelligible.

As a general rule, the graptolite slates in every part of the world contain no other fossils. I many years ago discovered in Wales, near Builth, the only shell I ever heard of in graptolite slates (the *Siphonotreta micula* M'Coy), and I was greatly surprised to recognize it also in Victoria, in the Deep Creek section. The crustacean genus *Hymenocaris* is represented by a new species, *H. Salteri* M'Coy, found in most of the graptolite slate localities.

In a different set of sandy, marly, and mud-stone beds—as at Woori Yallock, Yarra—we find an extensive series of the genera and many of the species of corals, trilobites, and mollusca of the "Bala beds" of North Wales; species of *Favosites,** *Palæopora*, *Calymene*, *Phacops*, *Beyrichia*, *Strophomena*, *Leptagonia depressa*, *Spirigera reticularis*, *Orthis elegantula*, the characteristic little genus *Cucullella*, *Murchisonia*, *Cornularia*, &c.; and some species new, and some identical with British ones, forming a group so completely reproducing the well known Bala beds as to afford a second case in support of the view of the general specific identity of the marine fauna over both hemispheres of the whole world in the earliest paleozoic times.

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* It is worthy of remark, that as on the continent of Europe the Devonian genus *Pleurodictyun* has now been found in Silurian strata, so in those beds in Victoria I find a new species (*P. megastoma*, M'Coy), with cells half an inch in diameter.

It is curious that I have not yet seen any trace of the genus *Trinucleus* in Australian beds, nor *Ampyx*, while all the above-mentioned genera of Trilobites, with *Acidaspis*, *Chirurus*, &c., are well marked.

I can scarcely close this part of the subject without drawing attention to the curious confirmation offered in Victorian geology of the view of Professor Sedgwick and myself, that there was a real systematic line of division between the Upper Silurian and the Cambrian and Lower Silurian, at the base of the Mayhill sandstone, and over the Caradoc sandstone—the Mayhill sandstone which we first defined and demonstrated to have Upper Silurian fossils only, and the true Caradoc sandstone full exclusively of Lower Silurian or Cambrian types; the previous confusion of these two sandstones, from the mingling erroneously of the fossils in collections, having given Sir Roderick Murchison the erroneous impression that his Upper and Lower Silurian groups of fossils (the distinctness of which he himself was the first to point out) were mixed together in the Caradoc sandstone, and that consequently the Bala beds, identical in fossils with those of the Caradoc beds (although formerly recognized by him as the type of the Cambrian system), could not be separated paleontologically from the Upper Silurian group. The Mayhill sandstone was one of the first formations I recognized on landing near Melbourne, with the usual Upper Silurian fossils; and it is now found here, as in Wales, to be slightly unconformable to the Cambrian or Lower Silurian, forming the obvious base of the former, and totally distinct in fossils from the latter.

3. *Note by F. B. Meek to his Review of Prof. Geinitz in regard to Nebraska fossils.* (See p. 170).—Since writing the remarks on the Nebraska fossils investigated by Prof. Geinitz, an extensive collection of specimens obtained at Nebraska City by Dr. Hayden and myself, during the progress of the geological survey of that state (now under his charge) and placed in my hands for investigation, enables me to give the following additional information.

On page 182, I expressed the opinion, from the examination of some rather imperfect specimens shown to me by Dr. White from Iowa, that the species referred by Prof. Geinitz to the so-called *Avicula pinnæformis*, is not only specifically distinct from that shell, but that it probably belonged to the distinct genus *Pinna*. A careful examination of a fine series of much better specimens from Nebraska City confirms my first conclusion in regard to its being a distinct species, and at the same time leads to the conclusion that it is an *Aviculopinna*, since its beaks are slightly removed from the extreme point of the shell, so as to leave a very small lobe in front, best seen in internal casts. It differs, however, specifically from the European *A. pinniformis*, not only in never attaining one-fourth as large a size, in its more uniform outline, and its much more nearly terminal beaks, but in being without any *traces* of radiating striæ, while its concentric markings differ in being strong, regularly disposed, rather distantly separated and abruptly elevated lines or lamellæ, unconnected with concentric wrinkles on any part of the valves; instead of fine crowded striæ, gathered into wrinkles on the ventral region. It is also provided on the upper half, with two or three large, very obscure radiating folds not seen on *A. pinniformis*, while its posterior margin also differs in being slightly sinuous just under the extremity of the hinge.

For this species I would propose the name *Aviculopinna Americana.* As might be expected, the very thin substance of this shell is seen under the microscope to have a prismatic structure, like that of other types of the *Aviculidæ.*

I avail myself of this opportunity to correct a few typographical errors that occur in my remarks on the Nebraska fossils in this number of the Journal.

Page 173, fifth line from top, for "respecting" read representing. Page 177, seventeenth line from top, for "thus far" read this far. Page 180, twenty-second line from bottom, for "they are," read it is. Page 184, sixth line from top, strike out the ? after *Rhynchonella.*

4. *Note on the Corundophilite of Chester, Mass.*—In a note on page 258 the writer has alluded to observations on the optical characters of the Chester chlorite made by Mr. Descloizeaux. Mr. Descloizeaux communicated his results to the writer in a letter dated Paris, Jan. 29, 1866, or a year and a half since. They are as follows.

Corundophilite is a clinochlore, in macled plates or crystals. The divergence of the axes is very variable, they being sometimes united, and at others widely separated. The bisectrix is *positive,* and distinctly inclined to the plane of cleavage or the surface of the plates. In one good plate I found 2E (or angle of divergence observed in the air) =65° for white light at 22° C. On heating to 200° C., the angle was increased from 3 to 4 degrees, a characteristic distinguishing clinochlore from pennine, which is always insensible to heat. The dispersion of the optical axes is quite distinct and $\varrho<v$. The hyperbolas are bordered by red interiorly and green exteriorly.

5. *Note on the optical characters of different micaceous minerals called Margarite;* by Mr. DesCloizeaux. (From a letter to J. D. Dana, dated Paris, August 15, 1867).—(1.) In 1847 I received from the vicinity of Sterzing, a foliated mineral having the plates a little concave, of white color and pearly luster, and well named *perl-glimmer,* which has the optical axes distinctly united.

(2.) The small specimen sent me recently by Mr. Dana as the original margarite is identical with one which had been sent me after 1848; it is in white laminæ mixed with some green clinochlore, and was regarded at that time as chloritoid. The laminæ are very much macled, and the divergence of the optical axes is accordingly very variable. I have found for the red ray, at 20° C. with

my specimen	2E=126° 24′;	in another plate, =117° 30′.
Mr. Dana's specimen	2E=109° 32′;	" " " 128° 38′.

The dispersion is very feeble, and it is rendered quite indeterminable by the numerous interlacings of the laminæ. The plane of the optical axes appears to be parallel to the longer diagonal. [This is the margarite of p. 259.]

The clinochlore mixed with the margarite is macled, with distinct dispersion ($\varrho<v$), and with strong double refraction. A plate gave me

2E=60° 48′ for the yellow ray.

(3.) In 1863 I received from Rammelsberg, under the name of *Barytglimmer* [the Œllacherite of p. 256] a so-called margarite from Pfitsch, which is white and pearly, and has been analyzed by Œllacher. The plates are very transparent, the double refraction strong, the dispersion feeble with $\varrho > v$, and orientation of the optical axes uncertain because of the irregular contour of the laminæ. I have found, at 20° C.

$2E = 79° 21'$ for the red ray; $2E = 78° 45'$ for the blue,

angles which correspond with those of ordinary potash mica.

6. *Eozoon Canadense in Finland.*—Prof. Pusirevski reports the occurrence of the Eozoon Canadense in limestone at Hopunwara in Finland. A lower and upper system of schistose metamorphic rocks have been distinguished. In the lower division of the upper system, at Pusunssari and Hopunwara near Pitkäranda occurs a limestone with serpentine, and the serpentine affords small nodules consisting of parallel layers which have the structure of the Eozoon. The facts are stated to prove that a large part of the rocks of Finland are Laurentian, and that the upper and lower systems probably correspond to the upper and lower groups of Canada.—*Bull. Acad. St. Petersbourg*, x, 151.

7. *Geological Observations in Colorado.* (Colorado Transcript, July 24, 1867.)—The late railroad surveys on Dry and Boulder creeks, St. Vrain, Big Thompson and Cache-a-la-Poudre rivers, and on the South Platte, under Capt. E. L. Berthoud, have shown that the Cretaceous strata on the east slope of the Rocky Mountains, extend eastward from the mountains at least four hundred and seventy-five miles; that in the upper beds, extending some seventy-five miles from the Rocky Mountains, coal of good quality can be found in large fields, which near the mountains in Jefferson county are covered on its west border by almost horizontal Tertiary beds, and through which extensive outcrops of Cretaceous coal occur.

8. *Geological Survey of Nebraska.*—By appointment from the General Government, the geological survey of Nebraska has just been commenced under the direction of Professor F. V. Hayden. Dr. Hayden is in his old familiar field, where he has explored in former years with great success, and we may expect very valuable results from his investigations. The experienced paleontologist, Mr. F. B. Meek, is associated with him in the work. The territory of Nebraska lies directly west of the state of Iowa, the survey of which state is going rapidly forward under Dr. C. A. White, its able state geologist; and this again directly west of Illinois, whose geological survey under Dr. Worthen has already made great progress, as shown in the admirable volumes recently published. The Reports of these regions when completed, will extend our knowledge of the geology of the continent on this side of the Rocky Mountains to 104° W. It is to be regretted, however, that the great and rich states of Ohio and Indiana yet remain but very imperfectly explored.

III. BOTANY.

1. *Manual of the Botany of the Northern United States, including the district East of the Mississippi and North of North Carolina and Tennessee, arranged according to the natural system;* by ASA GRAY, Fisher Professor of Natural History in Harvard University. Fifth edition, with twenty plates illustrating the Sedges, Grasses, Ferns, etc. New York: Ivison, Phinney, Blakeman & Co. Chicago: S. C. Griggs & Co. 1867, 8vo, pp. 701.—The former editions of this Manual have been duly noticed in this Journal. The first edition was published in 1848, and was at once accepted as the standard Flora of the region it embraced.

The work was entirely rewritten for the edition of 1856, and was revised upon the stereotype plates, some pages also being added, for the third edition (1862), and for the fourth (1863). The fifth edition has been mostly rewritten, several month's labor having been expended upon it.

The *Garden Botany* is excluded from this edition, but will be incorporated into a separate, more elementary work entitled *Field, Forest*, and *Garden Botany*. The *Mosses* and *Liverworts*, also, which were contributed to the previous editions by Mr. Sullivant, are now omitted, but the hope is expressed that these orders, together with the *Lichenes*, by Prof. Tuckerman, and perhaps the remaining orders of Cellular Cryptogamia, may before very long be published in a supplementary volume.

To the fourteen plates at the end of the volume, illustrating the genera of Grasses and Ferns, are now added six new ones, from original drawings by Sprague, to show the structure of the genera of Cyperaceæ. By the help of these accurately drawn figures the student will be able to identify easily the genus of any native or introduced plant belonging to these somewhat difficult orders.

While the general plan of the work is otherwise unchanged, a comparison of this volume with its predecessor shows that the learned author has taken new views of several natural orders, and that the generic and specific descriptions generally have been studied anew, and most faithfully compared with the plants as they exist in nature.

Among the changes in the natural orders to be particularly noticed is the uniting of *Nelumboneæ* and *Cabombaceæ* with *Nymphæaceæ*. This had already been done by Bentham & Hooker, and indeed we find *Nelumboneæ* made a tribe of *Nymphæaceæ* in DeCandolle's *Systema Vegetabilium*. But why not keep the name *Nelumbo* as originally written by Adanson in 1763, and adopted by Gærtner in 1788, a year before it was changed to *Nelumbium* by Jussieu? It would then accord with *Negundo*.

Another noticeable change is the restoration of *Tropæolum*, *Impatiens* and *Oxalis* to *Geraniaceæ*, in which order they were placed as "*Genera Geraniis affinia*" by its founder Jussieu. In the same order Dr. Gray has placed *Flœrkea* also, in the whole arrangement following pretty closely the views of Bentham & Hooker. The same authors had already included *Ribes* as well as *Parnassia* in *Saxifragaceæ*. The clustered staminodia of *Parnassia* are perhaps peculiar to the genus, but there are single staminodia or glands alternate with the stamens of *Francoa* and *Tetilla*, and the multifid lobes of the disk in *Brexia* is perhaps somewhat similar. Nor does *Ribes* alone produce berries, for they occur in several genera of *Escallonieæ*.

Halorageæ is separated from *Onagraceæ*, the points of difference being numerous and well marked. *Loganiaceæ* is recognized as a natural order and is placed next after *Gentianaceæ*. *Liliaceæ* is much extended, *Trillideæ* and *Melanthieæ* being regarded as tribes, the genera *Prosartes* and *Streptopus* placed in *Asparagineæ*, and *Narthecium* in *Lilieæ*. Some such consolidation of orders in the lilial alliance has seemed inevitable ever since it was shown by Dr. A. W. Chapman that the anthers of *Lilium* itself are extrorse in the bud.

The alterations in generic nomenclature and the uniting or dividing of genera are not very numerous, and every such change was apparently demanded by the progress of botanical science.

Atragene is reunited with *Clematis*, and *Pulsatilla* with *Anemone*. *Iodanthus* and *Turritis* go into *Arabis*, and *Arenaria* now includes *Alsine*, *Mœhringia* and *Ammadenia* (*Honkenya*). *Sanguisorba* is referred to *Poterium*, the characters of *flowers perfect*, *stamens few*, *carpel single*, *and seeds mostly smooth* not being constant, and the habit being the same in both. The restoration of the Linnæan genus *Houstonia* is most welcome, and we may now call the little *Bluets* by the name they bore when we first knew and admired this pretty flower. The Linnæan name *Ruellia* replaces the later one of Nees, *Dipteracanthus;* and *Stylisma* is referred to *Bonamia*, the characters of *styles somewhat less united* and *stamens less exserted* not justifying the separation of the American from the Madagascar species. *Benzoin* of Nees becomes *Lindera* of Thunberg, and the old genus *Habenaria* is restored to North American botany, for *Gymnadenia* and *Platanthera* both yield their places as distinct genera, Dr. Gray here returning to the view which he proposed in this Journal, in 1840.

A few specific names are altered, especially where older but less known names have been recently identified with well known species, as for instance *Ranunculus multifidus* (Pursh, 1814,) is substituted for *R. Purshii* (Richards, 1823), or where an American plant is proved to be identical with an older European species, as is *Viola Muhlenbergii* with *V. canina*. Not a few plants which were utterly unknown when the fourth edition of the Manual was published, in 1864, are now for the first time made known to science, and many more which were known to inhabit adjacent, or sometimes distant regions have been recently detected within our limits. A new *Polygala*, an *Aster*, a *Lobelia*, a *Pyrola*, two *Orchids* and two species of *Isoetes* are among the former, and the latter class includes a *Stellaria*, a *Parnassia*, another *Aster*, *Calluna vulgaris*, an *Ilex*, nearly a score of *Carices*, and several *Ferns*. In 1856 the indigenous Flowering plants and Acrogens known to inhabit the region covered by this Manual amounted to 2166, which number has now been increased by the zeal and industry of North American botanists to 2357, as is shown by a hasty count of the distinct and truly indigenous species described in the present volume.

The various Analytical keys have been prepared anew, and evidently with the greatest carefulness, the distinctions being based upon the important characters of the plants, rather than upon their trivial peculiarities, so that to a student who has thoroughly studied Physiological Botany, as taught for instance in Gray's Lessons, these Analytical keys will not only open an easy way to find the name of an unknown plant, but will also reveal much of the true relations of the plant to the whole Vegetable Kingdom.

In certain orders and genera the author has had the aid of collaborators who have devoted special attention to their several departments, among whom Dr. Engelmann takes the lead: all such assistance is amply acknowledged in the proper place.

As to thorough scientific arrangement, correct nomenclature, and accuracy and clearness of the definitions, this Flora is almost or quite unrivalled, there being no American, and few European works of the kind, which could bear comparison with it; and it will be well for the cause of American learning if this Flora, suited alike to the needs of accomplished botanists and unpracticed students, shall displace works which are wholly rejected by the former, and are used by the latter only to their own injury and confusion. D. C. E.

IV. ASTRONOMY.

1. *Recent Observations and Remarks of Hofrath Schwabe regarding Sun-spots and other Solar Phenomena.* Communicated by W. De la Rue, B. Stewart, and B. Loewy.—About two months ago Hofrath Schwabe called our attention to certain phenomena on the surface of the Sun, which he had noticed since last December, and which he recollected to have occurred before, but only at the time of a minimum in the number of Sun-spots. The phenomena are:—1st. *A total absence of faculæ or faculous matter.* 2nd. *Absence of the usually observed scars, pores, and similar appearances.* 3rd. *An equal brightness of the whole surface, the limb being as luminous as the center.*

Hofrath Schwabe desired us to go over his observations, which are at present at Kew Observatory, to extract similar facts formerly noticed, and to inform him whether some of these phenomena had also been observed in this country.

The observations were carefully scanned; and it was noticed that the phenomena occur only in years of minimum spot-frequency. The extracts, which we append, and which might have been multiplied, are quite sufficient to show the regularity of their recurrence, and also that the year 1833 was particularly characterized by the frequency of observations of them.

We also applied to the Rev. F. Howlett, whose well-known exquisite delineations of Sun-spots and faculæ gave us the best promise of learning something more relating to delicate changes on the surface of the Sun; but unfortunately Mr. Howlett's impaired health has obliged him to withdraw almost wholly from his usual application to Sun observations during the period in question. He however states in his answer, that "he had certainly noticed how uniformly bright the Sun's surface has been of late, in connection with an almost total absence of faculæ."

We think it right to state (without expressing our own opinion in the matter) that Hofrath Schwabe thinks he has noticed a connexion between Sun-spots and meteoric showers. He says in his last letter, "The minimum of spot-frequency coincides remarkably with the recurrence of meteoric showers, the period of rotation of which, viz., 33·2 years, agrees with a larger period of the sun-spots. In 1833 there was an extreme scarcity of spots (only 33 very small groups being observed), and in 1866–67, after 33 years the phenomenon repeats itself. From the 1st January until to-day, June 8th, I have only observed 6 small groups, and out of 133 days of observation, there were 100 without spots. In the year 1848, which is the middle of the 33·2 years period, there was a maximum of spots. If the 33 years' period should be established by future observations, then a maximum of meteoric showers would always occur after three years of the usual Sun-spot periods. Whether this periodicity existed before, I cannot decide, but there appears to have been a minimum of Sun-spots in 1798·5, and a maximum in 1816·8."

We are at present engaged in determining a curve of spot-frequency during the last forty years, founded, not on the *number of observed groups*, but on the *area of spotted surface*, as observed by Hofrath Schwabe; and we hope that by this means the periodicity will be represented with greater precision than before, and also that more light will be then thrown on the whole subject; but in the meantime we would call the attention of all observers to the fact, that in the present state of our inquiries into the physical nature of the Sun and into the connexion of cosmical phenomena, even the most delicate changes observed deserve great attention, and that nothing should be overlooked by those who take an active interest in this problem.—*Not. Roy. Astron. Soc.*, xxvii, 286.

2. *On a Meteor of July 18th*, 1867*;* by DANIEL KIRKWOOD, (Editorial correspondence dated Canonsburg, Pa., August 5th, 1867).—Mr. J. K. Larimore, A.B., has furnished me the following account of a meteor seen by himself, at Salem, Westmoreland County, Pennsylvania, on the 18th of July, 1867.

The time of observation was about 7^h 30^m P. M.—almost exactly at sunset. The meteor seemed to have originated in the S.E. quarter of the heavens, and it disappeared in the N.E. When first seen its elevation was about 40°, and it continued visible from four to five seconds. Its apparent diameter was estimated at one-fourth that of the moon, and it had a train three or four degrees in length.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Researches on Gun-cotton.—Second memoir. On the Stability of Gun-cotton;* by F. A. ABEL, F.R.S., V.P.C.S. (From the Phil. Mag., IV, xxxiii, 545, July, 1867, Supplement.)—The results of the many observations which had been instituted prior to 1860 upon the behavior of gun-cotton when exposed to diffused or strong daylight, or to heat, although they agree generally with those of the most recent investigations on the subject, as far as relates to the nature of the products obtained at different stages of its decomposition, cannot be regarded as having a direct bearing upon the question of the stability of gun-cotton produced by strictly pursuing the system of manufacture prescribed by von Lenk, inasmuch as it has been shown that the products formerly experimented upon by different chemists varied very considerably in composition.

The investigations recently published by Pélouze and Maury* on the composition of gun-cotton, and the influence exerted by light and heat upon its stability, are described as having been conducted with gun-cotton prepared according to von Lenk's system. The general conclusion arrived at by those chemists with reference to the latter branch of the subject was to the effect that the material is susceptible of spontaneous decomposition, under conditions which may possibly be fulfilled in its storage and application to technical and warlike purposes; and the inference is drawn, partly from the results of earlier investigators, and partly from the exceptional behavior of one or two specimens, that gun-cotton is liable to explode spontaneously at very low temperatures when stored in considerable quantities.

It has been shown, in the memoir on the Manufacture and Composition of Gun-cotton, published last year,† that modifications in the pro-

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* Comptes Rendus.

† Trans. Royal Society. For abstract see Phil. Mag., IV, xxxii, 145.

cesses of conversion and purification, which appear at first sight of very trifling nature, exert most important influences upon the composition and purity of the product. Gun-cotton of quite exceptional character has been discovered, in several instances, among samples received from Hirtenberg and among the first supplies obtained from Stowmarket; other exceptional products have also been produced by purposely modifying, in several ways, the system of manufacture as pursued at Waltham Abbey. The very considerable difference exhibited between some of these and the ordinary products in their behavior under equal conditions of exposure to heat and light, affords good grounds for the belief that the attainment of certain exceptional results, upon which the conclusions of Pélouze and Maury's report condemnatory of gun-cotton have been principally founded, are to be ascribed to such variations in the nature of the material operated upon.

Very numerous and extensive experiments and observations have been carried on during the last four years at Woolwich, both with small and large quantities of gun-cotton, for the purpose of completely investigating the conditions by which the stability of this substance, when under the influence of light and heat, may be modified, and with the view of ascertaining whether results recently arrived at in France apply to gun-cotton as manufactured in this country.

The principal points which have been established by the results arrived at in these investigations may be summed up as follows:—

(1.) Gun-cotton produced from properly purified cotton, according to the directions given by von Lenk, may be exposed to diffused daylight, either in the open air or in closed vessels, for very long periods without undergoing any change. The preservation of the material for 3½ years under those conditions has been perfect.

(2.) Long-continued exposure of the substance in a condition of ordinary dryness to strong daylight and sunlight produces a very gradual change in gun-cotton of the description defined above; and therefore the statements which have been published regarding the very rapid decomposition of gun-cotton when exposed to the sunlight do not apply to the nearly pure trinitrocellulose obtained by strictly following the system of manufacture now adopted.

(3.) If gun-cotton in closed vessels is left for protracted periods exposed to strong daylight or sunlight in a damp or moist condition, it is affected to a somewhat greater extent; but even under these circumstances the change produced in the gun-cotton by several months' exposure is of a very trifling nature.

(4.) Gun-cotton which is exposed to sunlight until a faint acid reaction has become developed, and is then immediately afterward packed into boxes which are tightly closed, does not undergo any change during subsequent storage for long periods. (The present experience on this head extends over 3½ years.)

(5.) Gun-cotton prepared and purified according to the prescribed system, and stored in the ordinary dry condition, does not furnish any indication of alteration, beyond the development, shortly after it is first packed, of a slight peculiar odor and the power of gradually imparting to litmus, when packed with it, a pinkish tinge.

(6.) The influence exercised upon the stability of gun-cotton of average quality, as obtained by strict adherence to von Lenk's system of manufacture, by prolonged exposure to temperatures considerably exceeding those which are experienced in tropical climates, is very trifling in comparison with the results recently published by Continental experimenters relating to the effects of heat upon gun-cotton; and it may be so perfectly counteracted by very simple means, which in no way interfere with the essential qualities of the material, that the storage and transport of gun-cotton presents no greater danger, and is, under some circumstances, attended with much less risk of accident than is the case with gunpowder.

(7.) Perfectly pure gun-cotton, or trinitrocellulose, resists to a remarkable extent the destructive effects of prolonged exposure to temperatures even approaching 100° C.; and the lower nitro-products of cellulose (soluble gun-cotton) are at any rate not more prone to alteration when pure. The incomplete conversion of cotton into the most explosive products does, therefore, not of necessity result in the production of a less perfectly permanent compound than that obtained by the most perfect action of the acid mixture.

(8.) But all ordinary products of manufacture contain small proportions of organic (nitrogenized) impurities of comparatively unstable properties which have been formed by the action of nitric acid upon foreign matters retained by the cotton fiber, and which are not completely separated by the ordinary, or even a more searching process of purification. It is the presence of this class of impurity in gun-cotton which first gives rise to the development of free acid when the substance is exposed to the action of heat; and it is the acid thus generated which eventually exerts a destructive action upon the cellulose-products, and thus establishes decomposition which heat materially accelerates. If this small quantity of acid developed from the impurity in question be neutralized as it becomes nascent, no injurious action upon the gun-cotton results, and a great promoting cause of the decomposition of gun-cotton by heat is removed. This result is readily obtained by uniformly distributing through gun-cotton a small proportion of a carbonate,—the sodic carbonate, applied in the form of solution, being best adapted to this purpose.

(9.) The introduction into the finished gun-cotton of one per cent of sodic carbonate affords to the material the power of resisting any serious change, even when exposed to such elevated temperatures as would induce some decomposition in the perfectly pure cellulose-products. That proportion affords, therefore, security to gun-cotton against any destructive effects of the highest temperatures to which it is likely to be exposed even under very exceptional climatic conditions. The only influences which the addition of that amount of carbonate to gun-cotton might exert upon its properties as an explosive would consist in a trifling addition to the small amount of smoke attending its combustion, and in a slight retardation of its explosion, neither of which could be regarded as results detrimental to the probable value of the material.

(10.) Water acts as a most perfect protection to gun-cotton (except when it is exposed for long periods to sunlight), even under extremely severe conditions of exposure to heat. An atmosphere saturated with aqueous vapor suffices to protect it from change at elevated temperatures; and wet or damp gun-cotton may be exposed for long periods in confined spaces to 100° C. without sustaining any change.

Actual immersion in water is not necessary for the most perfect preservation of gun-cotton; the material, if only damp to the touch, sustains not the smallest change, even if closely packed in large quantities. The organic impurities which doubtless give rise to the very slight development of acid observed when gun-cotton is closely packed in the dry condition, appear to be equally protected by the water; for damp or wet gun-cotton, which has been preserved for three years, has not exhibited the faintest acidity. If as much water as possible be expelled from wet gun-cotton by the centrifugal extractor, it is obtained in a condition in which, though only damp to the touch, it is perfectly non-explosive; the water thus left in the material is sufficient to act as a perfect protection, and consequently also to guard against all risk of accident. It is therefore in this condition that all reserved stores of the substance should be preserved, or that it should be transported in large quantities to very distant places. If the proper proportion of sodic carbonate be dissolved in the water with which the gun-cotton is originally saturated for the purpose of obtaining it in this non-explosive form, the material, whenever it is dried for conversion into cartridges, or employment in other ways, will contain the alkaline matter required for its safe storage and use in the dry condition in all climates.

2. *Scientific party for Sitka.*—A scientific party left San Francisco July 21st on the steam cutter *Lincoln* for Alaska. This party has been organized under the direction of Prof. Peirce, Superintendent of the U. S. Coast Survey, and is conducted by George Davidson, Assistant U. S. Coast Survey, as chief. With him are associated A. T. Mosman, Astronomer; Geo. Farquhar, hydrographer; with whom is associated I. Forney, as aid;—Hamel, engineer; Dr. Albert Kellogg, botanist; W. G. W. Harford, Conchologist; T. A. Blake, Geologist, and John Tidal, observer. The first business will be a geographical reconnoissance of the Coast.—*San Francisco Bulletin.*

3. *American Association for the Advancement of Science.*—The meeting of the Association at Burlington is just now closing as we put the last pages of this number to the press. We have to defer a notice of the proceedings to our November number.

OBITUARY.

Jeremiah Day.—Jeremiah Day, the venerable ex-President of Yale College, died at his residence in this city, on Thursday evening, August 22.

President Day had reached, on the 3d of the present month, the age of ninety-four years. His death will naturally occasion little surprise; yet the announcement of it will affect the hearts of thousands of pupils and friends who have long looked up to him with profound veneration and esteem.

He was born in New Preston, Conn., August 3, 1773. He first entered Yale College in 1789, seventy-eight years ago. Owing to ill health, he was absent from College for a considerable time, and did not graduate until 1795, the year when Dr. Dwight became president. The first official act of this eminent man was to preside at the Commencement at which the class of which President Day was a member was graduated. Mr. Day succeeded Dr. Dwight as teacher of the school which the latter had conducted at Greenfield, and remained there until his election as tutor in Williams College. In 1798 he became tutor at Yale, and while holding this office pursued theological studies and preached as a candidate for the ministry. In 1801 he was elected to the professorship of Mathematics and Natural Philosophy. His health at this period was feeble, and neither he nor his friends anticipated for him a long continuance of life. He was able, however, to enter on the duties of his new station in 1803, which he continued to discharge until 1817, when, on the decease of Dr. Dwight he was chosen president, and continued in this office until his resignation in 1846. He fulfilled the duties of the presidency with distinguished success and with the entire approbation of the college and of the public. He remained a member of the corporation until the last commencement, when, in consequence of his "diminishing powers of life,"—to quote his own apt phraseology—he severed this last link of official connection with the college which he had served so long and faithfully. President Day was the author of a series of mathematical text-books which have passed through numerous editions. He also published two metaphysical treatises on the subject of the Will, besides various papers in the New Englander and other periodicals. In 1810 he published a brief paper, in the Memoirs of the Connecticut Academy of Sciences, on the origin of meteorites, called out by the recent fall (in 1807) of the meteorite of Weston, in which he took the ground, that they were cometary bodies of the solar system.

President Day possessed a strong understanding, and was more remarkable for the balance and symmetry of his powers than for the extraordinary development of any one of them. He was an exact thinker and a clear reasoner. His great moral and religious excellence has been universally recognized from his youth up. None who knew President Day will feel that there is any exaggeration in applying to him the sentence: "Mark the perfect man and behold the upright, for the end of that man is peace."

He was the last survivor of the colleagues whom President Dwight selected and drew around him, and whose united labors first gave celebrity to Yale College. Kingsley, Silliman, and now Day, the oldest of the three, are gone; but they deserve to be perpetually honored by all who feel an interest in the institution to which their labors were devoted.

F.

E. J. PICKETT.—Edwin Judson Pickett was born near Rochester, N. Y., in 1830, and from early childhood that city was his home. Graduating from the University of Rochester in 1856, he afterward devoted his life to teaching and to the study of the natural sciences, geology finally becoming his favorite pursuit. In 1861, he received an appointment in the Institute at Mexico, N. Y., and in 1864, was appointed to the Professorship of Natural Science in the People's College at Havana, N. Y. After the failure of that institution, he took charge of a flourishing Collegiate Institute at Attica, Ind., and continued in the work until consumption, which had long before undermined his health, compelled him to seek his home and there await its lingering termination. He died on the 13th of October, 1866.

Mr. Pickett was of an exceedingly modest and retiring disposition, and did not seek society; but none who met him could fail to love him. An enthusiast in science, an indefatigable worker in whatever he put his hand to, and also an earnest Christian, his loss is a great one. With so few devotees, and so much work to be done, science can ill afford to spare one such. B.

FARADAY.—The telegraph brings the announcement that the eminent philosopher, Faraday, died on the 27th of August, in his 73d year.

VI. MISCELLANEOUS BIBLIOGRAPHY.

1. *Annals of the Astronomical Observatory of Harvard College.* Vol. II, Part II, and Vol. V. Cambridge, 1867. 4to, pp. 263, 215.—Part I of vol. II (Observations on Saturn) was published in 1857. Part II, just issued, contains a Zone Catalogue of 4484 stars situated between 0° 20′ and 0° 40′ north declination, observed during the years 1854–55, with the Cambridge equatorial. A similar catalogue of 550 stars (between 0° 0′ and 0° 20′ N. dec.) constitutes Part II of vol. i, where may be found the introductory matter pertaining to both series of zone observations. Two other like series still remain unpublished. These catalogues extend to stars of the 13th magnitude, and afford ample evidence of the ability and zeal with which the two Bonds, father and son, were accustomed to employ the great telescope which constitutes the principal instrument of the Cambridge Observatory.

The other volume just issued, the fifth of the series, gives the results of the latest labors of Prof. G. P. Bond—his elaborate observations on the great nebula in Orion. These observations were undertaken in 1857, but being interrupted, in 1858, by the work due to the great comet of that year, and by other causes, were resumed after the publication of the volume on the comet, and prosecuted as the failing strength of Mr. Bond would permit, nearly to the time of his death, in 1865. The splendid engraving of the nebula, which accompanies this volume, was executed under his eye, and the impressions taken in 1864. The observations were also reduced, for the most part, before the death of Mr. Bond, and the materials left in such a state of forwardness that, with the careful editorship of Prof. Safford, so long associated with Prof. Bond in the observatory, the work is now presented to astronomers, if not in as complete a form as it would have been had the life of the author been longer spared, yet in such a shape as to render it a noble contribution to astronomical science, and greatly enhance the already high reputation of its lamented author.

The volume is in the style of that on Donati's Comet, and the engravings are by the same artist. Besides the engraving, already referred to, from the drawing of Prof. G. P. Bond, it contains another representing the nebula as seen by Prof. W. C. Bond, with the same telescope, in 1848, and also two charts of the stars in and near the nebula, as laid down by the same author. The principal work of Prof. G. P. Bond consisted in determining, by differential observations, the positions with reference to θ Orionis of all stars visible with the Cambridge equatorial within an area extending 1° 30′ on each side of this star in declination, and $2^m\ 15^s$ each way in right ascension. This area of 3·36 square degrees embraces 1000 stars, or 298 to a square degree.

The different sections of the volume exhibit in detail the observations for the positions of these stars, a discussion of the observations by the Method of Least Squares, the resulting catalogue of positions referred to θ Orionis, a comparison of this catalogue with others, particularly Otto Struve's, Sir J. Herschel's, and Liapunoff's, the notes of Prof. Bond accompanying the observations, his original observations on the physical characteristics of the nebula, and a reprint, from the Proceedings of the American Academy, of his paper on its spirality, together with two appendices, one relating to the observations of the elder Bond, and the other to the errors of the equatorial as affecting the micrometrical measurements. With the discussions and explanatory notes of the editor, this volume presents materials of inestimable value to future observers of this nebula, and will contribute largely toward enabling them to settle the various questions relating to changes of form and brightness in this object, and to the variability of the stars in and near it. The latter question is discussed to some extent in the present volume.

Astronomers will await with interest the results of the observations on this and other nebulæ, which it is understood Prof. Safford is engaged in making with the great 18½ inch refractor of the Dearborn Observatory at Chicago, of which institution he is the Director.

His work of editing the volume before us was completed while he was acting director of the Cambridge Observatory, in the interval between the death of Prof. Bond and the accession of the present incumbent, Prof. Winlock.

2. *The Chemical News, and Journal of Physical Science.* American edition. New York, W. A. Townsend & Adams. July and August, 1867. pp. 48 and 60.—The English edition of the Chemical News is well known and justly appreciated in this country. When the republication of it in New York was announced, at a moderate subscription price, we felt that the publishers were doing the cause of science a real service. We have now before us the July and the August numbers. They follow closely their English original, with the important exception that the reprint, instead of appearing weekly, is issued monthly, having four of the English weekly numbers in one. Moreover, instead of giving the numbers consecutively and separately, the articles from each have been rearranged under their respective heads. The July number contains Nos. 387, 388, 389, 390, issued in London May 3, 10, 17 and 24; the August number, Nos. 391, 392, 393, 394, 395, issued May 31, June 7, 14, 21, 28; making a difference in time of two months. Again the parts issued are announced as Vol. I, Nos. 1 and 2, with no mention that they are really a portion of Volume XV, beginning near its middle. It is therefore quite impossible to tell in which of the weekly numbers, any given article was printed; and it is also impossible to find an article in either edition, by a single reference to the other. A reprint should be in every case an exact fac-simile of the original. The publishers state in a letter to the Editors of this Journal, that the preservation of the English dates and paging will "doubtless be hereafter introduced," and we hope that for the benefit of science it may be at once done.

3. *A Treatise on Astronomy, Spherical and Physical*, with Astronomical Problems, and Solar, Lunar, and other Astronomical tables, for the use of Colleges and Scientific Schools; by WILLIAM A. NORTON, M.A., Prof. of Civil Egineering in Yale College. Fourth edit., revised, remodelled and enlarged. 444 pp. text, with 114 pp. additional of tables, and numerous wood-cuts. New York, 1867 (John Wiley & Son).—Professor Norton, as his title page and more fully his preface states, has entirely remodelled his Astronomy, and adapted it thereby to the present state of the science. The chapters on astronomical instruments, comets, the physical constitution of the sun, zodiacal light, and others have been rewritten, and the text generally has been enlarged by the addition of more extended descriptions of astronomical facts, and an account of recent deductions with regard to the physical constitution of the heavenly bodies, and brief expositions of physical theories bearing on the subject, while the more difficult investigations of astronomical formulas occurring in the text of the former edition, have been transferred to the appendix. The work is an excellent college text book, and is rendered especially convenient for the practical astronomer by the mathematical tables, 96 in number, with which it closes.

4. *Elements of Chemistry, Theoretical and Practical;* by WILLIAM ALLEN MILLER, M.D., LL.D., Treas. and V. President Roy. Soc., V. P. Chem. Soc., etc. Part II, *Inorganic Chemistry.* From the 3d London edition. 806 pp., 8vo, with numerous wood-cuts. New York, (John Wiley & Son).—Messrs. Wiley & Son are doing good service to American science in the republication of the excellent work on Chemistry by Prof. Miller. There is no better one in the English language. Professor Miller has combined in his treatise the practical with the theoretical in a way that renders it useful and popular beyond the limits of the ordinary chemical class and lecture room. The volume is handsomely printed, and well illustrated.

5. *A Popular Treatise on Gems in reference to their scientific value, a guide for the teacher of Natural Sciences, the Lapidary, Jeweller, and Amateur, &c.;* by Dr. L. FEUCHTWANGER. 3d edit., 504 pp., 12mo. New York, 1867.—Dr. Feuchtwanger's treatise on gems is a popular work, containing much information of interest to science, the jeweller's art, and the wearers of jewels. It is illustrated by numerous plates, some of them colored, and very naturally so.

6. *Annual of the National Academy of Sciences for* 1866. 154 pp. 12mo.—This volume contains an excellent biographical notice of James Melville Gillis of the Washington Observatory, by B. A. Gould; a second of Benjamin Silliman, by A. Caswell; and a third, not unexceptionable, of Edward Hitchcock, by J. P. Lesley.

7. *Memoirs of the Boston Society of Natural History*, Volume I, Part II.—The following are the contents of this volume.—Page 131, Osteology of the *Colymbus torquatus*, with notes on its myology, with a plate; E. COUES.—p. 173, Zoological relations of the first-discovered traces of Fossil Neuropterous Insects in North America, with remarks on the difference of structure in the wings of living Neuroptera, with a plate; S. H. SCUDDER.—p. 193, On the parallelism between the different stages of life in the individual and those in the entire group of the Molluscous

order Tetrabranchiata; A. Hyatt.—p. 210, On the glacial phenomena of Labrador and Maine, with a view of the recent invertebrate Fauna of Labrador; A. S. Packard.

8. *Transactions of the American Entomological Society*, Vol. I, No. 1, 120 pp., 8vo, with two colored plates. Philadelphia.—This first number contains (1) Descriptions of American Lepidoptera No. 1, by A. R. Grote and C. T. Robinson; (2) Catalogue of the described Tenthadinidæ and Uroceridæ of N. America, by Edward Norton; (3) Notes on the Pompilidæ of N. America, with descriptions of New Species, by E. T. Cresson.

Proceedings Amer. Acad. Arts and Sci., Boston, 1866, Vol. VII.—p. 99, On an improved apparatus for the determination of vapor densities; *C. M. Warren.*—p. 103, Biographical notice of Jared Sparks.—p. 135, Comparative qualities of shot and guns; *D. Treadwell.*—p. 143, Enumeration of Hawaiian Plants; *H. Mann.*

Annals Lyc. Nat. Hist. of New York, Oct. Dec. 1866, Vol. VIII, Nos. 13, 14.—p. 351, Lepidopterological Contributions; *A. R. Grote & C. T. Robinson.*—p. 387, Notes on the nat. hist. of the scorpion; *R. Hill.*—p. 394, On some species of W. I. maritime shells in the cabinet of Amherst College; *H. Krebs.*—p. 399, On the classification of the Appredorus gibbosus of LeSueur, and Scolopsis sajanus of J. Gilliams; *T. A. Telkampf.*—p. 400, Descriptions of six new species of birds of the families Hirundinidæ, Formicaridæ, Tyrannidæ and Trochilidæ; *G. N. Lawrence.*

Proceedings Essex Institute, Vol. V, June, 1867.—p. 57, Fermeyer's Researches, etc., on Silk from Spiders; translated by *B. G. Wilder.*—p. 79, List of birds observed near Hamilton, C. W.—Part II of Naturalist's Directory, North America and the West Indies; Botany.

Proceedings Acad. Nat. Sci. of Philadelphia, 1867, No. 2.—Page 33, Structure of Lopezia; *T. Meehan.*—p. 34, Mammalogical notices; *J. H. Slack.*—p. 39, On Euclastes, a genus of extinct Cheloniidæ; *E. D. Cope.*—p. 42, Diœcious forms of Vitis vinifera; *T. Meehan.*—New species of Texan Myriapoda; *H. C. Wood.*—p. 44, Two new minerals from Chester Co., Pa.; *I. Lea.*—p. 45, A third study of the Icteridæ; *J. Cassin.*—p. 75, Notes of Micropus leucopterus of Say ("The Chinch Bug"), with an account of the great epidemic disease of 1865 among Insects; *H. Shimer.*

Proceedings Boston Soc. Nat. Hist., Vol. XI.—P. 83, On a sculptured stone from L. Utopia, N. Brunswick; *E. Bicknell.*—p. 89, List of the Birds of St.Domingo, with descriptions of some new species or varieties; *H. Bryant.*—p. 117, On some Fossil insects from the Tertiary of Green river, Colorado; *S. H. Scudder.*—p. 118, On monstrosities observed in wings of Lepidopterous Insects, and how they may be produced; *L. Trouvelot.*—p. 120, On a Fungoid parasite or Caterpillar Fungus, from the Philippine Islands; *S. Kneeland.*—p. 125, Habits of Migratory fishes; *T. Lyman.*

Proceedings of the Entomological Society of Philadelphia, Vol. VI, 1866-7.—Page 1, Lepidopterological notes, No. 2; *Grote & Robinson.*—pp. 31, 189, On the Pselaphidæ; *E. Brendel.*—pp. 39, 353, Fossorial Hymenoptera of N. America; *A. S. Packard.*—p. 106, Prof. Dana and his Entomological speculations; *B. D. Walsh.*—p. 122, Coloradian Butterflies; *T. Reakirt.*—pp. 152, 335, New N. A. Formicidæ; *S. B. Buckley.*—pp. 173, 287, On the Zygænidæ of Cuba; *A. R. Grote.*—p. 195, On certain N. A. species of Satyrus; *W. H. Edwards.*—p. 200, On certain Diurnal Lepidoptera of the U. S. and British Amer., No. 5; *W. H. Edwards.*—New species of Chrysophanus; *H. Behr.*—p. 209, On certain Entomological speculations—a Review; *A. S. Packard.*—p. 219, Two new N. A. Cecidomyiæ; *Osten Sacken.*—p. 221, Notes on Thyridopteryx ephemeræformis; *B. Clemens.*—p. 223, On the insects of the Galls of certain Willows; *B. D. Walsh.*—pp. 289, 296, Habits of a few Californian Coleoptera; on Usechus lacerta; on Rhadodera tuberculata; and observations on Phodaga alticeps; *G. H. Horn.*—p. 351, New species of Trigonalys; *E. T. Cresson.*—p. 445, Description of new species of N. A. Brachycerous Diptera; *A. R. Grote.*

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. XXXII.—*Address of* George Bentham, Esq., F.R.S., *President, read at the Anniversary meeting of the Linnean Society on Friday, May* 24, 1867.

In my address of 1865 I attempted a general sketch of the more important Transactions of Scientific Societies or Scientific Journals in which papers on Zoology or Botany are being published, passing over, however, for want of time and space, those in the English language, beyond a mere mention of their titles. I have been since requested to resume the subject, in so far as the North American publications are concerned; and I the more readily avail myself of this opportunity of doing so, as there are some points in regard to their proceedings on which it may be useful to institute a comparison with those of European institutions. In this review, however, I meet with one difficulty; I have never been in America, and have no personal experience of the working of their institutions, as I had of so many of the European ones, and am obliged to collect the data from their published reports. I trust, therefore, my friends across the Atlantic will excuse any errors I may have committed through inadvertency, or any material points I may have passed over from ignorance.

Our American colonists before the outbreak of the war of Independence had already begun to turn their attention to the cultivation of science, and especially to the investigation of the rich and varied fauna and flora of their territory, and several Societies or Academies for the promotion of these studies and the publication of transactions on the model of European ones were founded, either immediately before the great contest, or during the first years of the settlement of the States.

The American Philosophical Society, held at Philadelphia for promoting useful knowledge, was established in 1769, and soon commenced their 4to Transactions, the 1st volume having apparently been published in 1771, although, for some reason unknown to me, it bears the date of 1789. It contains nothing bearing upon Biology, except a few practical agricultural or horticultural papers; and the publication was interrupted during the years of trouble, until the Society was reorganized in 1780. A second volume is dated 1786, and four more complete the first series, which was closed in 1804 with the sixth volume. It contains, amongst a great variety of subjects, a few, mostly short, zoological papers chiefly in Ichthyology, Erpetology and Entomology by B. H. Latrobe, B. S. Barton, and Dr. Williamson, two small contributions to American Botany sent from Europe by Thunberg and Palisot de Beauvois, and an Index Floræ Lancastriensis by Muhlenberg. The labors of the Society appear then to have been suspended for nearly fourteen years; for it is only in 1818 that we find a new series commenced, and continued more or less steadily to the present time, the last received being two parts of the 13th vol. dated 1865. All are in 4to, but with gradually improving typography, paper, and illustrations, and a somewhat enlarged size adopted with the 10th vol., dated 1853. The series comprises all sciences among the subjects treated of; but a large proportion of the papers are devoted to the investigation of the Natural History (including Biology, Geology, Ethnology, and Linguistics) of the United States. J. Lea's malacological papers are perhaps the most extensive, going through nine out of the thirteen volumes. Entomology is next in order, in the earlier volumes by T. Say and N. M. Hentz, in the latter ones by J. L. Leconte, with a paper on Coleoptera by S. S. Haldeman, and another on Myriapoda by H. C. Wood, Jr. In other branches of Zoology, E. Hallowell on the reptiles of Cuba and the United States, S. F. Baird's Zoology of the Upper Missouri, and J. Leidy's papers, chiefly physiological or paleontological, are the most important, the contributions to Mammology, Ornithology and Ichthyology being few and short. In Botany there are several of Nuttall's descriptions of plants collected during his various expeditions, an enumeration of no less than 3,098 North American Fungi by L. D. de Schweinitz in the 4th vol., G. Engelmann's Botany of the Upper Missouri, E. Durand's Botany of the Great Salt Lake, and a few short contributions of minor importance. In 1838 the Society also commenced publishing their Proceedings in 8vo, after the model of European Societies. Of these we have 9 vols., from 1838 to 1864, including several papers of considerable length, occasionally illustrated by plates, but chiefly on Physical Sciences, Geology, or Paleontology. In Biology there is nothing beyond a few abstracts for the purpose securing priority of names, or short communications of very little importance.

The diminished proportion of Natural History papers in the later volumes of the Philosophical Society's publications is fully accounted for by the activity of another Society in the same city devoted exclusively to Natural Science. This Academy of Natural Sciences of Philadelphia was established early in 1817, and immediately began the publication of the 'Journal of the Academy of Natural Sciences in Philadelphia,' in 8vo, issued in parts at irregular intervals, with a few plates. The first series of 8 vols., from 1817 to 1842, was chiefly a receptacle for short papers in almost all branches of Zoology, as well as in Geology and Mineralogy, with a very few botanical contributions by T. Nuttall, G. Elliot, L. D. de Schweinitz, and S. W. Conrad, all of little importance.

In 1841 the Academy commenced publishing their Proceedings in 8vo, at short intervals, forming 8 vols., for the years 1841 to 1856 inclusive, and since then one volume (not numbered) for each year, from 1857 to 1865, the last received. They contain short communications, abstracts of the longer papers intended for the Journal, and some entire papers of greater length, with a few illustrations, woodcuts, or lithographs; and in some of the earlier volumes J. Cassin's Ornithological papers are accompanied by colored plates. In these 17 vols., will be found a valuable record of observations and numerous descriptions of North American species in almost every department of Zoology.

In 1847 the Academy resumed the publication of the more extended papers in a work issued as a new series of the Journal, but in a large 4to form, with plates executed in a superior manner, many of the zoological ones colored; corresponding, in short to the Transactions of other Societies. The five volumes issued up to 1863, besides a few papers on exotic animals or on general subjects, contain important and valuable contributions to the Zoology of the United States, amongst which may be particularly mentioned the papers in Ornithology by J. Cassin, Erpetology by E. Hallowell, Malacology and Conchyliology by I. Lea and T. A. Conrad, and Entomology by J. L. Leconte and R. Clemens, besides shorter communications in various branches of Zoology by naturalists of note. Botany is limited to Nuttall's account of Gambel's plants, a paper by M. J. Berkeley and M. A. Curtis on Fungi, and E. Durand's accounts of Heermann's and of Pratten's collections.

In this Journal I observe that the date of issue of the author's copies of each separate paper is given in a note to the table of contents. This is no doubt with a view to fixing a date on which the priority of discovery or of names is to be established. It has been universally acknowledged that priority depends upon the date of publication; but it has been a much debated question what amounts to a publication so as to fix that date. Is it to be the time when a paper is read, or when it has gone through the press so as to prevent any further alterations on the part of the author, or when it is actually given out for sale, or simply the date it bears on the title page? I believe that at the Royal Society the date of reading a paper is considered as a sufficient publication to establish rights of priority in a discovery or invention, and, in a legal point of view, with reference, for instance, to the law of patents, it seems reasonable that it should be so; for it is not fair that an inventor should obtain the sole right to his invention when the same or a similar one had been produced at the same time or before him, although not in a manner in which he could have cognizance of it; and for establishing such a fact the reading of a paper may be sufficient evidence. Both inventors can then enjoy the credit and benefit of their invention, but neither of them to the exclusion of the other. This also supposes that no alteration is allowed in a paper after it has once been read, unless it be clearly designated by brackets or otherwise, as I believe to be the practice of the Royal Society. In Biology, however, the case is different, the object is not only to establish that priority or rather independence of observation or discovery which can be enjoyed equally by two or more naturalists, but also the priority of name, which is a more complicated question, for an animal or plant cannot retain two names; when, therefore, it is found that it has been differently named by two or more naturalists it is necessary to decide which one should be exclusively adopted. In principle, it is the universal rule among botanists, and, I believe, a general one among zoologists, that, supposing there is no absolute objection to either name, that one is to be retained which was first fixed by actual publication,—its insertion in a work on sale or in general distribution, accompanied by diagnostic characters or other indications intended to fix its identity. The reading a paper at a meeting of a Society is not a publication for this purpose, only because it does not give fixity; the author himself does not feel bound by it and (possibly from the discussion evoked or observations made at the reading) may alter his names before or during the printing. A purely technical paper is, indeed, not even actually read, and often laid before the meeting in an unfinished state, the substance of it being verbally explained. The other objection, as to the impossibility of a naturalist not actually present having cognizance of a paper read at a meeting until it is in print is only one of degree, and may even tell the other way, for he may see it in print long before he can possibly procure a rival one from the antipodes although previously published.

It being admitted, then, that the date of a name is that of its actual publication, there still remains sometimes the practical difficulty of determining when that publication took place. *Primâ facie* evidence is the date given on the title-page of the work, but that is occasionally unfairly erroneous. The whole of Rees's Cyclopedia, in which much Zoological and Botanical matter is original, bears on the title-pages the date of 1819, when some of the volumes were published nearly twenty years earlier. Presl's Botanische Bemerkungen, with innumerable new or altered names of plants, is dated the second year before it was on sale. The Annales des Sciences Naturelles are notoriously antedated by several months. Grisebach's Monograph of Gentianeæ, dated 1839, was received in this country the previous November. The first parts of Ecklon and Zeyher's Enumeratio, and of Ernst Meyer's Commentatoines on South African Plants, each describing as new or renaming two or three hundred species of Leguminosæ, many of them identical in the two works, appeared almost simultaneously; but Ecklon and Zeyher's was actually published, as dated on the cover, in January 1836, whilst E. Meyer's, which was not issued to the public till the 14th of February 1836, has the ostensible date of December 1835. In order to do justice to the authors under similar circumstances extrinsic evidence has been generally admitted to correct the dates apparent on the title. In the case of Transactions of Scientific Societies this extrinsic evidence, often difficult to establish, is particularly required. There are generally two dates given, that of the reading, affixed to each paper, and that of the completion of the volume, given on the title-page; the former would be unfair to the rival observer, who might be superseded by alterations made after the reading of the paper, the latter equally unfair to the author, whose memoir, if in the first part of the volume, may have been in the hands of the public for years before the apparent date. In some Transactions this is remedied by printing the date of publication of each separate part; but even that is not always enough, for author's separate copies have sometimes been generally circulated, and even on sale, a considerable time before the complete part to which they belong. It is for the purpose of fixing this date (which ought surely to be admitted as a sufficient publication) that in the Philadelphia Journal the date of issue of the author's copies is, as above mentioned, noted in the table of contents. We have been considering whether a similar plan might not be adopted for our own Transactions, but it has been thought unnecessary to make the alteration, for the cases are very few where the author's copies are ready for delivery much before the part in which they are contained; and since we have regularly issued a part every autumn, the whole of the papers read during a session are thus actually published within a few months of the close of that session, thus always bearing the date of the same year. Where, however, as in some foreign Transactions, the author's copies are sometimes circulated a year or more before the part they are contained in is actually published, the noting the date of the former appears to be essential.

We are this moment in receipt of the 4th, 5th, and part of the 6th volume of the Proceedings of the Entomological Society of Philadelphia in large 8vo, with a few plates; edited by Mr. Cresson.

Boston was not long in following the example of Philadelphia in the foundation of a central scientific body. The American Academy of Arts and Sciences was established at Boston in 1780, and a few years afterward commenced the publication of 4to Transactions, entitled 'Memoirs of the American Academy of Arts and Sciences.' A first series of four volumes, dated from 1785 to 1821, contains, however, but little on Natural History, and from that date there appears to have been a long interruption. In 1833 a new series was commenced, with improved typography and illustrations. Of this we have seven volumes, from 1833 to 1860, and the first two parts of the 8th volume, dated respectively 1861 and 1863, when as in the case of other scientific works, the publication appears to have been suspended by the effects of the civil war. Although the majority of the papers in these Transactions are on mathematical, physical, linguistical, and other miscellaneous sciences, yet, in Natural History, they contain D. H. Storer's extended synopsis of the Fishes of the United States, as well as several detached papers of his on the Fishes of Massachusetts, Nuttall's account of the Birds of Massachusetts, some smaller contributions to insect anatomy by Haldeman and J. Leidy, and several important Botanical papers, including Sullivant's Bryology and Hepaticology of the United States, A. Gray's Plantæ Fendlerianæ, Notes on the Botany of Japan, and several minor papers, Grisebach's Plantæ Cubenses Wrightianæ, and Eaton's Filices Cubenses Wrightianæ et Panamenses Fendlerianæ.

In 1846 the Academy also commenced 8vo Proceedings, published at shorter intervals than the Memoirs, and forming six volumes, from 1846 to 1865. Besides the ordinary reports of Proceedings and abstracts of the longer Memoirs, they include some entire papers of considerable length, especially J. D. Dana's Conspectus of the Crustacea of the Exploring Expedition under Wilkes, M. J. Berkeley and M. A. Curtis's Enumeration of the Fungi of the same Expedition, Tuckerman's Synopsis of North American Lichens, G. Engelmann's of North American Cactaceæ, and Anderson's of North American Salices.

The naturalists of Boston further followed the example of Philadelphia in the establishment of a Society specially devoted to their own sciences. Their first efforts, however, were not successful. A Linnean Society of New England was formed in the winter of 1814–15, and during two or three years several meetings were held, papers read, and a few collections formed; but their only publication was a Report read at a meeting of the Society on the 18th of June 1817, on the part of a Committee appointed to inquire into the facts relating to the Sea-serpents supposed to have been seen on their shores. This report, a curiosity in its way, consists chiefly of the examination on oath of a considerable number of witnesses, the result of which appears to have led the committee to conclude not only that Sea-serpents of sixty feet or more in length had really been seen, but that a *Scoliophis atlanticus* about three feet in length, actually captured and described and figured in the report, was the young of the same species. After this effort the Society languished, and was dissolved in 1822, and the remnants of the collections were finally disposed of in 1830.

In that year a new Society was formed, which appears to have been yearly increasing in means and activity. The Boston Society of Natural History in 1834 commenced publishing papers communicated to them in the Boston Journal of Natural History, in 8vo, with a few plates; and the seven volumes issued up to 1863 are replete with valuable contributions to almost every branch of the Zoology of their country, with a few botanical papers, especially the Plantæ Lindheimerianæ by Engelmann and Gray. In exotic biology there also are papers by S. Cabot on the Birds of Yucatan, by J. Wyman on the Gorilla, by T. W. Harris on African Beetles, by A. A. Gould on African Shells, and by L. W. Bailey on Microscopical Organisms of Para. The Society also publish their Proceedings in 8vo, now in the 10th volume (1841 to 1866), which, besides abstracts, include a considerable number of short systematic enumerations, diagnoses, &c., both in Zoology and Botany. Of late years, however, the Society appears to have devoted its chief energies to the formation of a Library and Museum. The printed reports give a very flattering account of the new building into which the Library and Museum were moved in 1864, and which had been erected at a cost, including the cases, of above 100,000 dollars; the Library is reported as consisting in 1865 of above 7000 volumes, besides 1800 parts of volumes and above 2000 pamphlets, and the Museum as being far richer in most branches of Natural History than one should have supposed that a private Society would have been able to maintain. It will be interesting to watch in future years how far the resources they can depend upon will enable them to provide for the proper care and arrangement of their collections, which, to be useful, must be constantly and largely on the increase. The Treasurer's accounts show that besides the janitor (whom we should call porter) and some occasional help, there is but one paid officer, an eminent Entomologist, who is at the same time Custodian, Librarian, Recording Secretary, and Entomological Curator. For the thirteen other Curators of as many branches of Natural History, on whom alone depends the arrangement of the specimens, no remuneration appears in the accounts, whereas if the anticipations of increase sketched out in the Custodian's reports be realized, there must be full claims to the whole time of more than one Curator in most of these branches. The Society is making an experiment upon a large scale, but evidently depends much upon gratuitous aid; time alone will show whether that is less precarious on the other side than on this side of the Atlantic.

It is announced that the Boston Society's Journal is to be discontinued in the present form, but that the papers read will be published in quarto, under the new title of Memoirs of the Society.

The Harvard College at Cambridge contains a Museum of Comparative Zoology, which appears to be of great importance, and we understand that the very rich and valuable Herbarium of the distinguished Professor of Botany is also secured to the Botanic Garden of the University, but we know of no regular Transactions or Journals published in connection with the establishment.

The Lyceum of Natural History of New York was established in 1818, and commenced publishing the Annals of the Lyceum in 1823, in large 8vo, with a few plates. The seventh volume was completed in 1862, and the eighth is now in progress; they contain papers of considerable importance, chiefly in illustration of the Natural History of the States, including C. L. Bonaparte's Synopsis of North American Birds, some other papers in Ornithology by J. N. Lawrence and others, in Ichthyology by T. Gill, in Entomology by J. L. Leconte, J. W. Greene, and others, and numerous monographs and catalogues of shells by various conchyliologists. In Botany, Torrey's account of Rocky Mountain plants and United States Cyperaceæ, and L. de Schweinitz on North American Carices, occupy a considerable portion of the early volumes, beyond which there are only a few short communications from A. Gray.

The Elliott Society of Natural History of Charleston, South Carolina, published a volume of Proceedings, extending from November 1853 to December 1858, in 8vo, with a few plates. The most important papers are those of J. MacCrady on the Acalephæ of Charleston Harbor; among the smaller ones two are illustrated by plates, L. R. Gibbes on *Porcellana*, and a small list of rare plants by H. W. Ravenel.

The Academy of Science of St. Louis was established in 1856, and obtained an act of incorporation early in the following year. They publish Transactions and Proceedings in one continuous series under the former title, in 8vo, with a few plates; the first volume, a thick one, extends from 1856 to 1860, and two parts of the second are dated respectively 1863 and 1866. The papers relate chiefly to North American Fossils, with a few on various physical subjects, and one on an Egyptian *Papyrus*. In Biology there is little beyond Engelmann's monograph of *Cuscuta*, and other communications by the same author, more or less connected with the North American flora.

The only scientific journal published in the United States which I have met with is that which has acquired a worldwide reputation under the title of the American Journal of Science and Arts. It was commenced under the editorship of Professor Silliman in 1818, and published in parts in 8vo. After some interruptions during the first year or two, owing to the difficulty of arranging with the publishers, it has regularly formed two volumes in each year. A first series, conducted by Professor Silliman, and after the first few years at his own risk as proprietor, was closed in 1846 with the forty-ninth volume, a fiftieth being soon after added, made up of a general Index. Professor B. Silliman was then associated with his father, who has since died, and now conducts it at New Haven in conjunction with Prof. J. D. Dana, with the assistance of several other Professors of Cambridge and New Haven. It is now in the forty-third volume of the second series, having undergone but little change beyond a reduction in bulk from 1864, necessitated by the difficulties resulting from the war. In this journal Biology occupies less space than other sciences; there are, however, a few valuable papers in both Zoology and Botany, and under the head of scientific intelligence, every number contains critical notices or abstracts of works and other doings in Biology, which are always of great interest on this side of the water as well as in the States.

Washington is the seat of an Institution which, although not coming precisely within the definition of a Scientific Society, contributes largely to the promotion of our own, amongst other sciences, by publications after the model of Transactions of Academies, as well as by other means. It is, moreover, of a nature so different from any we have in this country, that it may not be out of place to enter into some detail as to its history, as gathered from the official reports, as well as from what we have experienced of its action. The founder was an Englishman, James Smithson, described as a graduate of the University of Oxford, who, having devoted a long life to the pursuit and encouragement of science, bequeathed his large property to the

United States, in trust, to found, at Washington, an Institution which should bear his name, and have for its objects the increase and diffusion of knowledge amongst men. The greater part of the property was realized in 1838, but considerable delay occurred in its application, owing chiefly to the great difference of opinion that prevailed as to the character to be given to the Institution, the objects of which were so vaguely indicated by the testator under these two heads, the increase and the diffusion of knowledge. At length, on the 10th of August, 1846, an Act of organization was passed by Congress, and the 'Smithsonian Institution for the increase and diffusion of knowledge' was established at Washington, under the management of a Board of Regents, fifteen in number, consisting of the Vice-President of the United States, the Chief Justice of the Supreme Court, and the Mayor of Washington, as *ex officio* members, three appointed by the Senate from its own body, three by the House of Representatives from its members, and six citizens appointed by a joint resolution of both houses; several of the principal executive officers of the States to be *ex officio* members, with occasional honorary members to be elected by the Regents. The total amount of the bequest received into the United States Treasury on the 1st of September, 1838, was 515,169 dollars, or above £125,000, deposited in the United States Treasury, and producing an annual income of $30,910, payment of which they have succeeded in obtaining in coin, making nearly £7000. There was also at the time of the establishment of the Institution an accumulation of interest amounting to $242,129, or nearly £55,000. For the application of these sums different schemes were strongly advocated by opposing parties. One, which found most favor with the national and popular party, was the formation of a general Library, Museum, and Gallery of Art in a building which, by its dimensions and architectural design, should be an ornament to the city, and a splendid memorial of the liberality of the founder; whilst others, entering more into the spirit of the bequest, urged that Smithson's object could never have been the glorification of Washington, or the localization of knowledge, but the promotion of science wherever or by whomever it was or might be pursued, and that the fund ought therefore to be employed in the encouragement of scientific and literary researches, and to the publication and transmission of their results to every quarter of the globe where civilization could reach, with such buildings, collections, and local appliances only as should be immediately subservient to these objects. At length a temporary compromise was effected between the advocates of local appliances and of active operations. It was determined that, besides the deposited capital which, by the Act, was to be left untouched, a portion of the income was at first, at least, to be annually invested, till the plans should be matured by experience, and that, of the remainder, one portion was to be expended in the formation of the library, museum, and gallery required by the Act, and the other in the more active operations recommended by men of science, whilst the accumulations already in hand were to be applied to the erection of the building, the relative proportions being left to the discretion of the Regents. During the first year the popular party found favor with the majority of them, and large sums were squandered on the building and local objects; but in time sounder views prevailed; the active operations have been extended with a success we all can appreciate, and the Institution has now attained a position of practical eminence and usefulness to science in strict conformity with the evident intention of the founder. This happy result (as far as I can judge from this distance, and without any personal communication) must be attributed mainly, if not entirely, to the well-devised plans of the Secretary, Prof. Henry, and to the zeal, activity, and perseverance with which he has devoted himself to their practical carrying out during the twenty years that have elapsed since the foundation of the Institution.

The edifice was originally to have been "a suitable one, constructed in plain and durable materials;" but the Building Committee, giving way to local influences, adopted a plan described in the Secretary's reports as being in the Lombard style, with useless buttresses, turrets, and towers, the convenience of the interior entirely sacrificed to architectural display; a judgment which an inspection of the plans and elevations given in R. D. Owen's 'Hints on Public Architecture' fully confirms. The money thus lavished on the freestone facade absorbed so much of the sum at command that the interior had to be run up in wood, lath, and plaster. The two wings were thus completed, and the main building presenting a frontage of 200 feet was far advanced, when the woodwork gave way, and had to be replaced with fireproof materials at very large extra cost, the roof alone of this main building remaining in wood. In that roof, where little danger was forseen, a fire broke out through the carelessness of some workmen in June 1864, destroying much private property, official papers, &c., although the most valuable stores, library, and collections of the Institution were preserved. After these disasters the ruling powers appear at length to be convinced that in the work of restoration and completion they must look more to substantial durability than to architectural effect; but they are sadly hampered by the size of the building, so much beyond their real wants, and its costly style, which cannot now be altered. In this building were to be deposited:—

(1) A general National Library, with provisions by which

the Institution would be encumbered by all the trashy productions of the day, without means of procuring those really valuable to science; this they have succeeded in warding off, and are endeavoring to limit their library to works bearing on science. They have bestowed especial pains, and appear to be already rich in Proceedings and Transactions of learned Societies and other serials connected with science; and it is hoped that they will be gradually relieved from their general and useless literature by the transformation of the Congress Library into the great National United States Library, instead of attempting to impose the burthen on a private Institution incapable of sustaining it.

(2) A general Museum, as comprehensive and multifarious in its objects as our own British Museum, with a similar aim at popular display. But the impractibility of such a Museum, which would soon absorb an annual income equal to their whole capital, is now felt, and the collections are to be henceforth restricted—1st, to those made by the United States Exploring Expedition, the care of which has been imposed on the Institution by Congress; 2nd, a limited museum of type specimens, principally of the products of the American Continent, or such as are thought of especial interest as illustrating the Smithsonian publications; and 3rd, collections for distribution, to which I shall presently revert.

(3) A Gallery of Art; but the absurbity of imposing upon such an Institution the care and maintenance of a National Gallery is so evident, that the collections in this respect have been limited to some plaster casts of distinguished individuals, and a very few pictures they could not refuse the charge of.

In the active operations of the Institution the knowledge they are called upon to promote has been divided, as in the great Academies of the Continent of Europe, into the three great branches of Physical Science, Moral and Political Science, and Literature; the Fine Arts being nominally included in the latter class, but really somewhat extrinsic in character, and practically passed over. What has been effected by the Institution in the second and third classes, it is beyond my province to inquire; and even in the Physical class I do not venture to express any opinion on their efforts in the promotion of Meteorological, Astronomical, and other Physical observations. In Biology their exertions have been directed to the publications of Memoirs, Reports, and other papers, to the promotion of Exploring Expeditions, as well as of local investigations, to the distribution of specimens, and to the facilitating the interchange of publications and other vehicles of knowledge.

The principal publications of the Institution are in two series, the one in 4to, the other in 8vo, corresponding generally to the

Transactions and Journals of Scientific Societies. The 4to series, entitled 'Smithsonian Contributions to Knowledge,' copiously illustrated by well-executed plates, has now attained its 15th volume (although 14 only have as yet reached us,) the first having been published in 1847, less than a twelvemonth after the foundation of the Institution; the 8vo series was only commenced in 1862, without plates, and now forms six large volumes. In these two series Physical Sciences and Natural History (Biology, Paleontology, and Geology) occupy nearly equal proportions; there are also extended ethnological and philological Memoirs, and a few smaller ones on miscellaneous subjects. The Biological papers, whether systematic or physiological, are almost entirely illustrative of the fauna and flora of North America, the most important of which are (including two or three now in the press) Monographs or Catalogues of North American Bats by H. Allen; Mammals and Birds by S. F. Baird; Oology by T. M. Brewer; Reptiles by S. F. Baird and C. Girard; Cottoid Fish by C. Girard; Marine Invertebrata and Crustacea by W. Stimpson; Shells by W. G. Binney, P. P. Carpenter, T. Prime, W. Stimpson, and G. W. Tryon; Insects by J. L. LeConte, H. Hazen, H. Loew, F. E. Melsheimer, J. G. Morris, R. Osten Sacken, H. de Saussure, S. H. Scudder, and P. R. Uhler; in Animal Physiology by J. Dean, J. Jones, S. W. Mitchell, G. R. Morehouse, and J. Wyman; in Insect Embryology by L. Agassiz, and in Microscopic Biology by J. W. Bailey and J. Leidy. In Botany we have W. H. Harvey's Nereis Boreali-Americana, illustrated by 50 plates, A. Gray's Plantæ Wrightianæ Texano-Neo-Mexicanæ, and three papers by J. Torrey on Californian plants. Each one of these papers is separately paged in order to facilitate their separate distribution.

The Smithsonian reports form a volume in 8vo for each year; they contain, besides the official reports of the proceedings of the Institution for the preceding year, extracts from correspondence, reports of explorations, &c., several important scientific papers translated from foreign languages, and some original ones on various scientific subjects. These reports to Congress are printed at the expense of Government, with the exception of a few occasional woodcuts supplied by the Institution.

In the way of promoting explorations and collection of observations, the efforts of the institution have hitherto been judiciously confined as strictly as possible to America, Northern and Arctic, Central and Southern; but in this field they have done much, and the exertions of the Institution, with considerable means at its command, cannot but remind one of the equally strenuous and successful exertions, as to one branch at least of science, of a single individual in our own country, the late Sir William Hooker, or of the more general ones of our

Royal Geographical Society. On this subject I cannot do better than quote a passage from the Secretary's Report of March, 1865, when speaking of the aid afforded in the organization of government explorations by land and by sea:—" Whether by official representations to the heads of departments or personal influence with officers and employés, it has secured the engagement of individuals competent to collect facts and specimens; it has instructed persons thus engaged and others in the details of observation, it has superintended the preparation and in some cases borne the expense of the necessary outfits, has furnished fresh supplies from time to time to the collectors while in the field; received the collections made and preserved them for future study, or at once consigned them to proper persons, both at home and abroad, for investigation, directing the execution of the necessary drawings and engravings for the reports, and finally superintending the printing and even the distribution of any available copies of the completed works to Institutions of science. Prior to the establishment of the Institution but little had been done by the Government in the way of scientific explorations, with the exception of that under Captain Wilkes. But since then, nearly every United States expedition, whether a survey for a Pacific Railroad route, a boundary line, or a wagon route across the Rocky Mountains, or an ordinary topographical expedition, has been influenced or aided more or less as above stated. Besides these, similar explorations have been carried on without any reference to Government, and either entirely or in a great measure at the expense of the Institution and always at its suggestion." An enumeration follows of above twenty of the more important of these expeditions directly organized by the Institution in the northern and western portions of North America, in Mexico, Central America, Cuba, Jamaica, and Bolivia.

In making collections by means of these expeditions or otherwise, the object has not been so much to supply a large museum with permanent specimens, or duplicates for regular exchanges, as to distribute the specimens where it is thought they might best advance the cause of science, by being most accessible to the largest number of students engaged in original investigations. Much has been done in this way in the encouragement of local societies in rural districts for the collection of specimens and the recording of natural phenomena; and, as far as botany at least is concerned, the collections that come to Europe show that the official statements on this head are not extravagant boasts.

I have said that in its Library the Institution is endeavoring to obtain a complete collection of Transactions and other works of a serial character issued by learned bodies. This they expect to obtain chiefly by a liberal system of exchange, and for that purpose it is now in correspondence with upwards of 1200 of the Societies, Public Libraries, and principal Universities of of the Old World.

The last head I shall refer to is that of International Exchanges. From the first, one of the special objects of the Secretary's plans was to facilitate the direct correspondence between the learned institutions and scientific men of the two worlds, and the free exchange of their publications. Year by year the plans for this purpose have been modified and improved until they have attained an extent which seems only to require control to guard against its being abused by private interests under the name of science, or, perhaps still more, of benevolence. At the present time the Institution receives, at periods made known through its circulars, any books or pamphlets of scientific, literary, or benevolent character which any institutions or individuals in America may wish to present to a correspondent elsewhere, subject only to the condition of being delivered in Washington free of cost, and being accompanied by a separate list of the parcels sent. Where any party has any special works to distribute, the Institution is prepared to furnish lists of societies or persons to whom they might be usefully sent. The articles and volumes, when received, are assorted, packed, and dispatched to the agents of the Institution in London, Leipzig, Paris, and Amsterdam. The boxes are there unpacked, and the contents distributed through the proper channels. The returns for these transmissions are received by the same agents, packed and forwarded to Washington, from which point the parcels for other parties are sent to their proper destination. All the expenses of packing, agents, freights, &c., between those four towns and Washington are borne by the Institution, the parties concerned only paying the local carriage from or to these great centers. In this interchange the Institution has obtained special facilities on the part of custom-houses, railroad and steamboat companies; and the scientific and literary world have largely availed themselves of this useful system. The number of packages reported as dispatched to foreign countries from Washington in 1864 was 1011, contained in 63 boxes, weighing 20,500 lbs., whilst the packages received in return was 2482, exclusive of those for the Smithsonian library.

We have nothing of the kind in this country, and the difficulties of interchange of books and specimens with the Continent are much felt; the comparative cheapness of freights is more than made up by the complicated agencies and other extra charges, which can scarcely be avoided even by the few who are initiated into the secrets of the business. A box of specimens for Hamburg, which the carrier took to the wrong continental steamboat agent in the city, cost me 22s., when for 25s., I might have gone myself to Hamburg and taken the box with me as luggage. The sending one or two volumes, or a small packet of specimens into Germany, is often prevented by the difficulties and expense attending it. It is not to be expected that any Association in this country should be endowed with funds especially devoted to the diffusion of knowledge, enabling them to undertake the transmission gratis of scientific works and specimens; but it appears to me that if, for instance, the six Scientific Societies which are in future to be assembled in this locality were to join in salarying agents in London and in three or four of the principal centers of science on the Continent, who should receive for transmission, pack, and periodically despatch scientific parcels, and distribute return packages, charging to individuals their proportions only of actual disbursements, the gain to science would be considerable and the charge to each society but small.

In glancing over the general tendency of the biological papers contained in the works I have ennumerated, it will be seen that, although it is scarcely half a century since our American brethren applied themselves in earnest to the investigation of the natural productions and physical condition of their vast continent, their progress, especially during the latter half of that period has been very rapid until the outbreak of the recent war, so deplorable in its effects in the interests of science as well as on the material prosperity of their country. That is, however, now fortunately over; and although the means of every scientific institution are still sadly crippled by the high prices and heavy duties resulting from that war, yet many of them appear to be resuming their former activity; and it is to be hoped that they will now again receive every encouragement, public and private, in the vigorous prosecution of their researches. The peculiar condition of the North American Continent requires imperatively that its physical and biological statistics should be accurately collected and authentically recorded, and that this should be speedily done. It is more than any country, except our Australian colonies, in a state of transition. Vast tracts of land are still in what may be called almost a primitive state, unmodified by the effects of civilization, uninhabited, or tenanted only by the remnants of ancient tribes, whose unsettled life never exercised much influence over the natural productions of the country. But this state of things is rapidly passing away; the invasion and steady progress of a civilized population, whilst changing generally the face of nature, is obliterating many of the evidences of a former state of things. It may be true that the call for recording the traces of previous conditions may be particularly strong in Ethnology and Archæology; but in our own branches of the science, the observations and consequent theories of Darwin having called special attention to the history of species, it becomes particularly important that accurate biological statistics should be obtained for future comparison in those countries where the circumstances influencing those conditions are the most rapidly changing. The larger races of wild animals are dwindling down, like the aboriginal inhabitants, under the deadly influence of civilized man. Myriads of the lower orders of animal life, as well as of plants, disappear with the destruction of forests, the drainage of swamps, and the gradual spread of cultivation, and their places are occupied by foreign invaders. Other races, no doubt, without actually disappearing, undergo a gradual change under the new order of things, which, if perceptible only in the course of successive generations, require so much the more for future proof an accurate record of their state in the still unsettled condition of the country. In the Old World almost every attempt to compare the present state of vegetation or animal life with that which existed in uncivilized times is in a great measure frustrated by the absolute want of evidence as to that former state; but in North America the change is going forward as it were close under the eye of the observer. This consideration may one day give great value to the reports of the naturalists sent by the Government, as we have seen, at the instigation of the Smithsonian Institution and other promoters of science, to accompany the surveys of new territories. For present purposes we want very much a digest of the new observations. Synopsis of some classes of insects and other animals appear indeed in a complete, or nearly complete form in the Smithsonian and other publications above mentioned; but we have as yet no complete flora of North America. The admirable one began so many years since by Torrey and Gray has been so long interrupted that it requires rewriting from the beginning; and there is no greater service to the science that the distinguished Cambridge Professor could now render than the resumption of that work, in any, however much abridged form.

The American Museum reports suggest some topics worthy of consideration with regard to the general question of Natural History Collections. The first thing that strikes one is the want of a National Central Museum for the reception of as complete a representation as can be obtained of the North American Fauna and Flora, with so much at least of foreign specimens as may be required for comparison and generalization. For this they seem to have depended on the efforts of private scientific bodies; but the progress of these, so far as they have gone, seems to corroborate the experience of the Old World, that the useful maintenance of such an establishment is absolutely hopeless unless it be supported at the public expense, or by the annual proceeds of a sufficiently large inalienable capital. In America, as in Europe, almost every Natural History Society, small or large, begins by contemplating the formation of a Museum, undefined as to limits; contributions are invited and donations thankfully received from every quarter, without reference to value or practical utility. At first, whilst the Librarian, Secretary, or other manager takes a personal interest in the arrangement and exhibition of the objects received, when donors can bring their friends to see their contributions displayed on shelves or in glass cases with their own names paraded on the cards, when most of the members of the Society have the new feeling of a personal share in the ownership of the collections, when the number of specimens received is blazoned forth as a matter of pride and gratification, these incipient museums may have considerable influence in stimulating collectors and observers of nature. But after a time these collections outgrow the Society's means, the specimens which may be required for study or comparison are encumbered by a mass of trash presented by persons who do not know what else to do with it, or who have attached a false value to the fruits of their own labors, the permanent officer can no longer have time to select for exhibition what is worthy of it, nor to arrange those which might be available for reference, and the Society cannot afford to maintain the necessary staff of keepers, even if they have a building large enough for the purpose. Packages and specimens are, however, still received, exhibited at meetings to elicit formal thanks, and then consigned to oblivion and decay in cupboards and garrets, the members generally taking no further interest in what they can make no use of. If afterwards attention is called to this state of things, it may be felt that something must be done; the gratuitous aid of patriotic members is called in, and the museum may be more or less purged of trash and partially arranged. But gratuitous aid, like voluntary subscriptions, is generally given on the spur of the moment, and can never be depended on for long continued and ever increasing demands; the collections relapse into a condition worse than the previous one, till at last the Society is obliged to dispose of them as a clog on, instead of an aid to, their operations. Such is the history of many a museum I could name on the Continent and at home, including our own, and such seems destined to be the career, on a large scale, of the Boston Society, notwithstanding its large invested funds, if something is not done to give it a permanent independence of individual disinterested efforts. It is now in the gratuitous aid period; but when its present stores are doubled or quadrupled, when the thirteen or fourteen unpaid curators must not only give their whole time to it, but require each of them one or more assistants to do the work usefully, it will not be done at all; and unless the Society receives that extensive support which can only be expected from the State, stowage, neglect, and destruction must ensue. It is no doubt considerations such as these that have induced the Smithsonian Institution to repudiate the burthen attempted to be imposed on them of a National Museum which even the whole of their income would be insufficient to maintain.

There is another class of museums which the Smithsonian Institution appears to be promoting and assisting, with what results I have not sufficient means of judging; these are local museums on a smaller scale in the smaller cities and provincial towns. We have many such in Europe, both on the Continent and in our own country, and if judiciously formed and adequately maintained, ought to be very useful in encouraging the taste for observation at home, and giving the scientific visitor from a distance authentic information on the natural history of the district. But too many of them depend on the fluctuating support of voluntary contributions, and follow the fate of museums of societies. I have had occasion to go over many of these local museums in various parts of the Continent and some of our own, and it had been my intention to have collected information, and in one of my addresses to have prefaced some general observations on the subject, with a detailed review of all our provincial Natural History museums and Associations; but so many of them are unfortunately more or less in a state of collapse or uselessness, that I feared that special notes might be invidious. I may perhaps be allowed, however, generally to remark, that it appears to me that local provincial societies cannot better apply their funds and influence than in the establishment, on a permanent and independent footing, of a public museum, confining their publications to matters of purely local interest, which the general naturalist is not to be called upon to notice; that this museum should aim at completeness in representing the local district; that exotic specimens should be restricted to such a limited number of representative types or specimens for comparison as their means will afford, selected solely in proportion to their utility in the museum, without reference to the individuality of the donor, or, if a certain number of complementary specimens must be retained for a time in order to keep up the public interest in the establishment, such specimens be unhesitatingly expelled as soon as the cause for retaining them is gone.

In conclusion, I may perhaps be excused in alluding to some general principles in the management of large museums, which are inculcated by the Smithsonian Institution, more or less followed on the Continent, formerly almost ignored with us, but now more generally recognized. These are liberality of exchanges, facilities for study, and rejection of trash, principles which it may be hoped are even gaining upon that most essentially conservative establishment, our gigantic and, I might almost add, all-grasping British Museum. The large sums annually voted for its support by the nation justify, indeed, not only the exhibition on a most extensive scale of attractive specimens for the occasional instruction or excitement to observation they may give to the general public, but also the concession to the popular party of a rare show for the thousands of gazers who would otherwise congregate for less harmless amusements; but a large proportion of the support or contributions to the museum is granted or given in the name of Science, and Science has a right to its full share in the consequent benefit. Whether Natural History be or not under the same roof as Art, Literature, and Archæology, Science has a claim upon Parliament to provide buildings and maintain a staff adequate to the scientific arrangement of the collections; and she has, I think, also a right to call on the management, be they a composite Board of Trustees or individual responsible heads, to reserve days, accommodation, and specimens for examination and study, to allow of the requisite appliances of light and heat in the process, to cause the stores that have accumulated for more than half a century to be turned out of their hidden repositories, to have what is useful to scientific researches rendered accessible for the purpose, the surplus duplicates employed in a liberal system of exchanges, with an eye quite as much directed to the distributing them usefully as to the pecuniary value of any expected return; and to authorize the consigning to the dust-cart all absolute rubbish occupying valuable space.

ART. XXXIII.—*The Action of Sunlight on Glass;* by THOMAS GAFFIELD.

[Concluded from page 252.]

THE comparative power of glass of different kinds to transmit the actinic rays I have tested, by placing underneath pieces of each kind, pieces of easily changing glass, (white plate or Belgian sheet glass,) exposing them one year, and noticing, at the end of that period, the comparative depth of the yellow or pink color to which the under pieces had changed. The result of my experiments proved that the most easily transmissive of the colorless glasses were the English crown, French plate, two kinds of white crystal sheet made in Massachusetts, (from the celebrated Berkshire white sand,) the New Jersey sheet glass, one kind of English plate, and one kind of Belgian sheet, and about in the order which I have named them.

Of the colored glasses, the blue transmitted the most, the purple less, the red and orange the least, the glasses under these two and the yellow and green showing little or no change.

This last experiment proves the propriety of the preference given by photographers to blue glass for skylights, because it transmits the blue rays, which exert the most actinic power. But it may be added, that a colorless white glass, or bluish white,—if one which will not change by sunlight to a yellow or rose color, owing to the presence of manganese, or any other cause,—is equally good, as it will transmit all the rays, and among them, the actinic or blue ones. In proportion as any kind changes to a yellow or rose color, it will lose its power of transmission, and its value as photographic glass. I have seen specimens of the two kinds of white crystal sheet made in Massachusetts, before alluded to, which answered the demands of photographic artists. Of foreign glass, I have noticed a fine bluish white sheet, made lately without manganese, from a certain excellent manufactory in Belgium, and one kind of English crown glass.

Should plate glass be required, the most permanently enduring, or least likely to assume a yellow color, are a superior kind of white plate, made by the French and Belgian Plate Glass Companies, and an excellent quality of German crystal plate, made at a long established factory in Hanover.

I desire to say here, however, that it is not the place where any glass is made, which determines its good character, but the actual constituent materials and the superiority of its manufacture.

Manufacturers are frequently changing their mixture or "batch," so that any results given with one set of samples might differ from those made with another set, from the same manufacturers. For this reason, in noticing any differences which may occur in experiments made by any of our readers, this fact should be considered as an explaining cause.

I have seen specimens of glass from a factory which changed to a yellowish tinge in a few months, others which changed to a purplish hue, and still others from the same factory, which hardly changed at all. A difference in the mixture, (or batch, as it is termed), makes a difference in the tinge of the specimens from the same factory, both before and after exposure to sunlight. The chief points for photographers are to get glass made from as pure materials as possible, of as light a color as practicable, and free from oxyd of manganese. A glass like either of those named above, as most easily transmitting the actinic rays, might be good for one year or more, and then become very much injured for photographic effects, by the change of color to yellow or pink by sunlight.

Any photographer can make these observations practical, by testing the action of sunlight for six months or a year, on all the specimens offered him for sale. And all manufacturers can make them practical, by making their glass of pure materials, which will not have to be "doctored," to use the glassmakers' term for the use of manganese; or by allowing the glass to assume its natural color, even if it be a little blue or green, rather than to run the risk of its subsequent change to yellow or purple by exposure to sunlight.

In the Comptes Rendus for January 14th, 1867, Pelouze says, (and we believe he is the first and only writer who has made this observation):

"Exposure to red heat decolorizes the glasses which have been made yellow by sunlight, or to speak more exactly, they retake the light green shade which they had before exposure. A second exposure to sunlight produces a second coloration, similar to the first, and a red heat makes it disappear again. These phenomena can be reproduced indefinitely. The glass preserves its transparency and does not give place to any striæ or bubbles." He also says:

"I possess specimens of glass rendered violet by sunlight. All present the property of being decolorized by heat. A temperature of 350 degrees is not sufficient. It is necessary to have that employed in the reheating of glass in general, and that is in the vicinity of red heat. The glass decolorized by heat when exposed to sunlight retakes the amethyst color which it acquired the first time, loses it anew when it is heated; and these curious phenomena can be reproduced without cessation."

In confirmation of this most interesting statement of Pelouze, I have exposed in a glass stainer's kiln, several specimens of glass which had been changed by the action of sunlight, some to a yellow and some to a purple color. The exposure to an extreme red heat made the glass assume, some a white, some a yellowish white, and some a green color, which were probably the original colors. These specimens were taken from windows where they had been exposed from a few years to more than half a century. Further experiments, which I have already commenced, will show whether we can reproduce the exact original colors by heat, after being changed by exposure to sunlight.

We have in the same kiln exposed some dozen original and unexposed specimens of what are called colorless window glasses of different kinds and shades of color, and found them unchanged in the slightest degree by the action of great heat, while similar specimens have been changed in a few days, weeks or months, by the simple action of the sun's rays. Fifteen specimens of really colored glasses, (red, green, yellow, &c.,) have been exposed in the same way without any change of color, except a very slight one in a few specimens which were burnt or over-heated.

In Poggendorff's Annalen, Berlin, of May 1st, 1839, is recorded the following interesting fact by A. Splittgerber:

"I would mention a curious fact, in which the sunbeams have, if I may say so, done something in the art of penmanship; not only on the surface, but by inscribing characters through the body of the glass; and, though the matter is based upon causes well known by experience, yet there has probably never before been so striking an instance of their effect known. I am in possession of a plate of glass which was used as a window pane for more than twenty years, and on which was an inscription in gold letters. This inscription was taken off by grinding the plate on both sides, and polishing it so as to have a new surface. When the glass had been polished, the inscription could again be clearly seen. The parts which had been under the letters remained white, while the remainder of the plate had assumed a violet tint, in consequence of the manganese it contained, a coloring which permeates the whole mass, as the grinding of the surface proved. The uncovered part of the plate, especially when laid upon a white background show the clearly readable characters."

The same or a similar instance is related by Dr. Herman Vogel in the Photographische Mittheilungen, Berlin, of Sept., 1866.

Desiring to produce a similar result, we made an inscription on a piece of Belgian sheet glass, in part with gold and silver leaf, and in part with black and white paint. The gold and silver leaf were soon washed off, but the black and white painted letters remained, and being removed after an exposure of nearly two years, the words stood out in clear contrast and full proportions, the inscription being in the original color of the glass, and the surrounding portions having been changed by the action of the sunlight to a purple color.

A very interesting experiment can be made, to show the gradually increasing effect of the sunlight on glass, by taking a piece of easily changing glass, say 4×20 inches, painting black a strip 4×2 inches at each end to preserve the original color, and then exposing the strip to sunlight. At the end of one, two, four, six, eight and ten months, one, two and three years respectively, cover with black paint a strip 4×2 inches, and at the end of three years remove all the paint, and you will have, in a single piece of glass, the original color and all the gradations of change effected by exposure from one to thirty-six months. I have made a similar one with Belgian sheet glass exposed nearly two years. It is one of those interesting experiments which speak for themselves, and defy suspicion or contradiction.

I have made an experiment for one year with two kinds of easily changing glass out of doors, and out of the direct rays of the sun, and found that they were both slightly affected, and changed toward a yellowish color. I did not expect any change, but can, perhaps, properly account for it, on the ground that it was the result of the action of diffused sunlight. It is barely possible that the sun may for a few minutes in some days of the year have cast some reflections when I was not present, in the dark corner in which I placed my specimens.

It may be, that the action of the sun's heat produced the slight effect noticed. If so, it would be an interesting confirmation of Tyndall's experiments, and of his theory of the correlation of forces. I do not consider my single experiment as entirely conclusive, and shall make others, which will give us more material for proper theories and conclusions.

The experiments which I have carried on for four years embrace one specimen of optical glass, a few kinds of flint glass and glass ware; sixteen kinds of French, Belgian, German and English plate glass, four kinds of American, English, French and Belgian rough plate, two of American and English crown glass, ten kinds of American, Belgian, French and English white sheet glass, four kinds of American, Belgian and English ordinary sheet glass, fifteen kinds and shades of English colored glass, four of opaque, white enamelled and ground glass, and one piece of the rough metal of American sheet glass; in all, about sixty varieties.

I have watched and recorded in some experiments, the results from day to day, in others from month to month, and season to season. I have now commenced a series, in which I may record results from year to year, for ten years or more. In these, it may be found that specimens of what are called colorless glasses changed to a yellow color by exposure for a year, may by much longer exposure be turned to a yellowish pink and a purple. And some which have been entirely unaffected, may be affected by an exposure for ten or twenty years. Perhaps some of the colored glasses may show signs of a change of hue or shade.

These new experiments include rough and polished plate, crown, cylinder, ground, enamelled and colored glass. I have also begun to expose *under* several of these kinds of glass, pieces of easily changing glass, which I shall take in from year to year, these *under* pieces showing the power of these glasses above them to transmit the actinic rays.

The most easily changing glasses are a certain kind of white plate, which changes from a white to a yellowish color, and a certain kind of Belgian sheet, which the manufacturers used to make of a brownish yellow, (they now make it of a bluish or greenish hue, and it is not so easily changed,) which changes to a flesh color, or a pinkish hue. I have accordingly taken these two kinds, for my *under* glass experiments. Under each of several kinds, to be exposed from one to ten or twenty years, I have placed pieces 4×2 of the white plate. I shall take in one piece at the end of the first, second, third, fourth, sixth and tenth year. These six lights will show the increased action of the transmitted rays from year to year. By comparing the different series with each other, one can perceive the comparative actinic power of each kind of glass, or rather, their comparative power of transmitting actinic rays.

Another interesting *under* experiment is the following. I have placed under one piece of each kind of glass exposed, a piece of easily changing glass, which I shall take in at the end of the year.

At the beginning respectively of the second, third, fourth, sixth and tenth years, I shall place under the same piece, another strip of 4×2 inch glass, taking in each piece at the end of the year of its exposure. This series will show the diminishing or increasing power of the glasses under which they have been exposed, to transmit the actinic rays; in other words, will show whether exposure to the sun increases or diminishes the actinic power of the glasses exposed, and renders them better or worse for photographic purposes.

I have taken a piece of 4×18, of easily changing white plate, painted with black paint two inches of each end, to preserve the original color, and exposed the piece. At the end of the year, I shall paint over two inches more of the glass. At the end respectively of two, three, four, six, and ten years, I shall paint over two inches more. At the end of this time, or a longer term, I shall remove all the black paint, and on one light, I shall have all the grades of changed color and shade produced by their different lengths of exposure. I shall lay aside one piece of 4×18 white plate, taken from the same sheet with the exposed light, in order to compare the original with the changed specimen.

I have painted and exposed, just in the same manner as above described, a piece of 4×16 of easily changing Belgian sheet glass.

To show a speaking proof of the painting power of the sunlight, I have taken a piece of 4×6 Belgian sheet and covered it with a thin plate of brass, having the following letters cut out of it: T. G., Jan. 1, 1867. I have taken another piece 4×6 Belgian, and stuck on with gum shellac the two letters T. G. After exposure of one year or more, the removal of the brass plate and letters will show in the former case, rose or purple colored letters on a brownish yellow ground, and in the latter, brownish yellow letters on a rose or purple colored ground.

A similar experiment as the above, I have commenced with two pieces of white plate, and the simple letters T. G., without the date. The result of the experiment in a year or more, will be to show in one case, yellowish letters on a light colored ground, and in the other, light colored letters on a yellowish ground.

I have thus given, as briefly as possible, and yet as fully as desirable, an account of my past and present experiments. New ones are suggested from year to year. I trust that this interesting field for observation and experiment may be worked in other countries. There is ample room for research in the application of chemical knowledge, of qualitative, quantitative, and spectral analysis, and of photogenic tests, to discover the exact action and causes of the interesting effects of the sun's rays, which have here been noticed.

Theories.—The interesting phenomena of which I have given an account, have given rise to many theories to account for their cause. Some attribute them to the presence of oxyd of iron, and some to oxyd of manganese. Exactly how the change takes place is a question on which writers differ, although it is my opinion that the precise explanation can only be given after a multiplication of experiments, and a thorough examination of exposed and unexposed specimens of glass by quantitative and qualitative analysis, and perhaps by spectral analysis and observation of photogenic effects, or photogenic tests.*

We will briefly state the part which the oxyds of iron and manganese play in glass making. In almost all kinds of window glass, and in some poorer qualities of flint glass, and glass ware, materials are used which are not perfectly and chemically pure. The sand, the carbonate or sulphate of soda, and the lime, one or all, contain slight impurities of iron, the protoxyd of which gives glass a green color. To correct this, after the batch is partially melted, a little oxyd of manganese, called *glass-maker's soap*, is put into the crucible or glass pot; some of the oxygen of the manganese flies off to the iron, and converts the protoxyd into peroxyd of iron. The peroxyd gives a yellowish color to the glass, and this, being complimentary to the natural pink of the manganese, is neutralized, and the glass is thereby made of a light color. When the sunlight acts upon glass thus made, the nice equilibrium between the oxygen of the iron and the manganese is disturbed, and sometimes the yellow, and sometimes the pink or purple color is produced. I have produced all shades of the purples, running from

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* Since writing the above, by the kindness of Mr. John A. Whipple, the distinguished photographer of Boston, I have been enabled to show, by the comparative darkening of sensitive paper under several exposed and unexposed specimens, the effect of exposure to sunlight for one year. The loss of actinic power, or power to transmit the actinic rays, was in proportion to the change of color. This was in some varieties of glass quite perceptible, but in all will be more so after an exposure of several years.

pale lavender, into the lilac, mulberry, flesh, amethyst, rose, violet, pink and deep purple. I have produced, or seen specimens, showing all shades of the yellow, from the brownish yellow, up to the brightest gold color, and I have several series of specimens, in which the green has gradually changed into the yellow, and the yellow gradually run into the pink and purple.

Pelouze, in an article in the Comptes Rendus, of Jan. 14th, 1867, sets forth the following theory.

"There is in glass colored yellow in sunlight some protoxyd of iron and sulphate of soda. Light provokes between these matters a reaction from which results peroxyd of iron and sulphid of sodium. The heat brings about an inverse reaction and reproduces sulphate of soda and protoxyd of iron. From thence comes the return of the glass to its primitive color. Analysis comes to the aid of this theory in demonstrating in glass rendered yellow by sunlight, the presence of an infinitely feeble, but still very sensible proportion of a sulphid, whilst the reactions do not show the slightest trace in the same glass before their exposure."

"It may be asked, why glasses colored by the reduction of the sulphate, or the direct introduction of a sulphid into their mass, resist an equal or superior heat to that which produces the decoloration of glass become yellow in sunlight. Here is the answer. In glass made yellow at a high temperature by the reduction of sulphate, the iron is found in a state of protoxyd, which cannot react in any degree upon the sulphids. Therefore the glass remains colored. In glass made yellow by sunlight, the iron is peroxyd and in consequence, in a condition to change the sulphid into sulphate, when we expose the glass to the action of heat."

In reference to glass made violet color by sunlight, he says, "The coloration seems to be due to the fact that the peroxyd of iron gives up a part of its oxygen to the protoxyd of manganese conformably to one of the two following equations.

$$Fe^2O^2+MNO=2(FeO)+MNO^2$$

$$\text{or}\quad Fe^2O^3+2(MNO)=2(FeO)+MN^2O^3.$$

The reheating of glass, that is to say, the action of a temperature of red heat, produces an inverse reaction, which explains the decoloration. In which we have

$$2(FeO)+Mn^2O^3=Fe^2O^3+2(MnO).\text{"}$$

Bontemps, in an interesting article in the Comptes Rendus of Feb. 4th, 1867, attributes the changes in color to the presence of oxyd of manganese. He also remarks that he thinks that the violet color occurs only in glass in which the silicates have a base of potash, and the yellow in cases where soda is used. I doubt the correctness of this opinion, as I am quite sure that I have several specimens colored violet, which contain no potash at all in their composition.

I have also specimens which are colored both yellow and violet in the same piece, the yellow portion in one case having been produced by a certain length of exposure, and then having been covered with black paint, while the violet portion was produced by longer exposure.

As before stated, I have noticed changes in what are called colorless glasses, from light colors approaching white, to yellow and pink or purple. I have noticed also a change in a few specimens from a light green to a bluish shade. The former may be accounted for by the presence of manganese, a very minute proportion of which oxyd will have a sensible decolorizing effect in a crucible of melted glass metal. Pelouze's theory of the peroxydation of the iron may have some weight in determination of the cause of the yellow or pink color by the action of sunlight. But I know not how to account for the change of one specimen each of plate, crown, and sheet glass in my possession, from a greenish white to a bluih tinge, not mingled with either yellow or purple.

I have been pleased to find the interest in these experiments by photographers, who have long noticed that they could take better pictures under a newly glazed skylight, than under one which had long been exposed to sunlight. The cause of this change is, that the slightest yellow color interferes with the transmission of the actinic rays, and a very deep shade will cut them off in a very great degree. My experiments with glasses under other glasses proved which was best for photographers' use, information which all can gain by exposure of the specimens of various manufacturers which may be offered them. The most pure glasses of light green, or bluish white color are the best for photographers, and when I say *pure* glasses, I mean those most free from oxyd of iron or manganese, but especially of the latter, which, I think, is the cause of nearly all the changes which I have observed. Mr. J. W. Osborne, of New York, the gentleman who has done so much to bring the art of photo-lithography to perfection, and into practical use, writes as follows:

"I believe your researches will prove of much practical importance, and I wish the glass manufacturers could be got to give serious attention to the subject. It takes but a very slight tinge of yellow to cut off twenty-five per cent of the actinic rays. I am forced to work under glass, because of the protection from the wind and weather, but in doing so, I sacrifice in any case much of the light. I have to increase the time of exposure proportionately. With the best of glass, the loss from reflection and absorption is considerable. This may be fearfully increased by the color, and if that undergoes a continual change for the worse, the state of things is exceedingly unpleasant. I was warned by a photographic friend in England, to take care of a certain kind of cheap French glass, made for glass rooms, which turned yellow; but I had no notion that the evil was so general as you appear to have found it. The subject is of such vital importance to photographers, that I intend drawing the attention of that friend to what you have done."

I am indebted to Mr. Osborne for bringing our researches to the notice of his friends at home and abroad, who have contributed interesting articles and valuable information on the subject to the Philadelphia Photographer, (October, 1866,) the London Photographic News, (August 2, 1866,) the London Photographic Journal (Aug. 15, 1866,) and the Photographische Mittheilungen (Sept. 1866).

It may seem singular that so long an experience in the window glass business, had not at an earlier period drawn my attention to the subject of this article. But my experience is not singular. In conversation with many glaziers and glass dealers, I have seldom found one who was aware of the great change of color effected by sunlight. Few have supposed that specimens were to be found in any other windows in our city, than those on Beacon street facing Boston Common and the south, and exposed to the full force of the sun's rays. But having my attention now particularly directed to the subject, I never pass a window without detecting where any considerable change has been effected. I have found them in all portions of the city, and most generally in those positions which face the east and south. The color is most easily detected, when the glass has been ground or enamelled, or where a white window curtain forms a good contrasting back ground. Many people suppose that the very distinctly marked purple plate glass in Beacon st. was imported of this color, and that it is now no longer made; and hence the reason why the windows looked like checkerboards, when broken lights were replaced by those of the usual light greenish color of plate glass.

On this point I have convinced many who had held contrary views, by showing pieces from which the putty on the edges has been removed, and displaying beneath the original color. When the putty covered the glass, the sun's rays could not reach it, and the color was unchanged. Such specimens are quite interesting. I have had many conversations with old glaziers, dealers and consumers of glass, and also with those who stain and enamel it. I have thus gathered specimens of various kinds and colors, and of differing lengths of exposure from old windows. The oldest specimen was one of crown glass set in a church in Lexington, Massachusetts, in 1794, from which the windows were removed in 1846, and since used as covers for hot-beds. The original color, found by removing the putty from the edges, was a light green, and the present, after seventy-three years exposure, is a purple color. I have never yet met any one who has seen glass in original imported packages, of the purple color made by exposure to sunlight, and until I do, I shall adhere to my opinion, that all purple or rose colored glass which is seen in our city windows, was made so by said exposure. I have very fortunately found an octogenarian, who has furnished me with some glass which was imported, he thinks from some part of Germany, which is of a light green or yellowish green color. The glass was imported more than thirty years ago. Much of that which has been set in his windows facing the south is now purple. An experiment with the original glass, commenced this summer, showed a perceptible change in color in one day, and in two weeks, the change toward purple was so marked that I have no doubt that this color will be distinctly visible in less than a year. If two years were occupied in the erection of the Beacon street houses, or any others in which the plate glass purpled by sunlight is found (as I am informed was the fact in some cases), then the result of the single experiment named above is a sufficient reason for the mistaken belief of many occupants and owners to-day, that the glass was purple when imported. It was probably changed from yellowish green to purple before the houses were finished, and the owners had taken possession.

The action of sunlight which I have spoken of in this article, must not be confounded with that called "rust" or "stain," which is occasioned by exposure to the weather, and manifests itself in two ways; first, by a disintegration and roughening of the surface, sometimes producing all the effects of ground glass; and secondly, by an apparent formation of an infinitesimal coating of oxyd on the surface, on which the play of light gives all the colors of the rainbow, as with the action of light on the infinitesimal grooves of the surface of mother-of-pearl. This is simply surface action, whereas the action of sunlight permeates the whole body of the glass, wherever the rays directly strike it.

The writer of this article, (compiled in the midst of the busy duties of mercantile and official life,) makes no pretension to accurate scientific knowledge, but gives the results of his observations and methodical experiments on a well known phenomenon, in the hopes that they may add some mite to the sum of human knowledge, and may stimulate and aid those who are better versed in scientific studies, to ascertain the causes and exact operations of this interesting power of the sun's rays to paint the products of art, as they do so beautifully and wonderfully the works of nature on the mountain, in the forest and field.

Boston, Mass., July, 1867.

ART. XXXIV.—*Remarks on Prof. Geinitz's views respecting the Upper Paleozoic rocks and Fossils of Southeastern Nebraska;* by F. B. MEEK.

[Concluded from p. 187.]

AFTER preparing the remarks published in the last number of this Journal on the Nebraska fossils figured and discribed by Prof. Geinitz, I had an opportunity, through an incidental connection as Paleontologist, with the Nebraska Geological Survey (in charge of Dr. Hayden, under the direction of the Hon. Commissioner of the General Land Office), to devote about two months to field explorations in the Coal-measures of that region. In order to trace out as fully as possible, the order of succession of the various beds of the whole series, our observations commenced with the Subcarboniferous, and Lower Coal-measure rocks on Desmoines river, Iowa. Over two weeks were thus occupied with Dr. White, the able State Geologist of Iowa, and his efficient assistant, Mr. St. John, accompanied by Dr. Gill of Washington, D. C., in an overland journey from Iowa City, Iowa, westward to Nebraska City, Nebraska.

The remainder of the time was mainly spent with Dr. Hayden and party, in studying the Coal-measure rocks along the Missouri from Omaha, Nebraska, down to Kansas, and in excursions into the interior, including a journey out the Union Pacific Rail Road to its terminus, at that time within five miles of the northeast corner of Colorado. A short time was also devoted to investigating the Coal-measures in the environs of Sumner and Atchison, Kansas, and St. Joseph, Missouri, with Mr. Scarborough, a scientific gentleman of the first mentioned place.*

During these explorations, numerous natural sections, shafts, drifts, quarries, borings, and excavations of various kinds were carefully examined, and large collections of fossils and other specimens obtained. It would of course be out of place here, if I had the authority to do so, to attempt even a general sketch of the results of these explorations.† I am permitted, however, to mention a few of the facts observed, having a bearing on the question in regard to the age of the rocks at and near Nebraska City, referred by Prof. Marcou and Prof. Geinitz to the Permian.

In the first place, it may be well to give a few additional items of information in regard to some of the fossils figured by Prof.

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* Our examinations in Iowa and Nebraska, excepting the excursion out the Pacific Rail Road, were made while traveling by land, in wagons or on horse-back, provided with assistants and the necessary fixtures for camping, wherever we wished to stop.

† The facts observed in Iowa will be published in the Report of Dr. White to the proper State authorities; and the results of the observations in Nebraska, in Dr. Hayden's official Report to the Hon. Commissioner of the General Land Office.

Geinitz, from this region, in part mentioned in my remarks published in the last number of the Journal. For convenience, in doing so, I will use the names by which he has designated them, as follows:—

Cyathaxonia, taf. v, f. 3. This form from Plattsmouth, compared by Prof. Geinitz, *C. tortuosa* Mich., is the same described by McChesney from the western Coal-measures under the name *C. prolifera.* The other represented by fig. 4, of the same plate from Nebraska City, is probably only a variety of the same. At any rate Dr. Hayden found well-marked examples of the *C. prolifera* in bed B at Nebraska City, that cannot be distinguished on direct comparison with authentic specimens of that species from the typical localities in Illinois.

Allorisma elegans King. The shell figured under this name is certainly a distinct species, and not a *variety* of the *elegans*, since a fine series of specimens show it to be *exceedingly* constant in all its characters (which are well represented in Prof. Geinitz's figure), while it differs from that species not only in never attaining one-tenth the size of larger examples of that shell, but in being much narrower and more distinctly truncated behind, as well as in having its umbonal slopes *always* sharply keeled. Its umbones are also more elevated.

Schizodus Rossicus de Vern. As nearly as the little shell referred by Prof. Geinitz to this species resembles the published figures of *S. Rossicus*, a direct comparison shows it to be quite as closely allied to *S. curta* of Meek and Worthen, from the Coal-measures of Illinois, and Atchison, Kansas.* It agrees exactly in size, and all other known characters with the *S. curta* excepting that it is a little more compressed, and has slightly less elevated beaks. On comparison with the figures of *S. Rossicus* given in the geology of Russia, the Nebraska shell is found to have its anterior ventral region *constantly* more prominent and rounded, and its posterior margin more distinctly, and more nearly vertically truncated, so as to give more angularity to the posterior ventral extremity, as is well represented by Prof. Geinitz's figures. It is possible these differences may be only due to a want of care in the artist, in drawing the Russian shell; otherwise I should not hesitate to regard the Nebraska form, that from Illinois, and those figured from Russia, as three closely allied, but distinct species. That under consideration is exceedingly constant in all its characters (as shown in a good series of specimens) and exhibits no tendency to the variations of form said to be presented amongst the different individuals of *S. Rossicus.*

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* The beds at Atchison, Kansas, hold a lower stratigraphical position than the rocks above the mouth of Platte river, referred by Prof. Marcou to the Mountain limestone.

Aucella Hausmanni Goldf. In the last number of this Journal, I expressed the opinion that the form figured under this name, is the same as *Myalina Swallovi*, so common in the western Coal-measures. This conclusion is strengthened by the occurrence of well marked examples of the *S. Swallovi* in the collections before me from Prof. Marcou's bed C, at Nebraska City; while no other similar form was found there or elsewhere in these rocks. On the other hand, the casts figured by Prof. Geinitz (from the Permian of Kansas and not from Nebraska) under the name *Myalina perattenuata*, and which I had supposed to belong to that species, must be the *M. permiana* of Swallow, though they have more attenuate beaks than is common in that species. The two forms, however, are very similar, and in some of their varieties can not be readily distinguished, as has been ascertained from comparison of specimens recently obtained by Dr. Hayden. The typical *M. permiana* does not occur, so far as known, on the Missouri.

Spirifer laminosus McCoy. The species figured by Prof. Geinitz under this name, is, as already stated, the common and widely distributed *S. Kentuckensis* of Shumard. In the last number of this Journal, I expressed the opinion that it would probably be found to be a true *Spiriferina*, an opinion I believe also entertained by Dr. Shumard. On recently examining several examples from Nebraska City, and other localities in Nebraska, Iowa and Kansas, I find that they not only show under the microscope the punctate structure, but that they also possess the internal plate of *Spiriferina*. It is an extremely variable shell in the convexity of its valves, as well as in the proportional length of its hinge line. The more ventricose varieties with a short hinge, are sometimes very similar to *S. octoplicata* Sowerby, to which indeed the species has been referred in Stansbury's Salt Lake Report. The individual figured by Prof. Geinitz is a compressed variety (its compression however is *partly* due to accidental pressure) with an extended hinge, and shows a small plication in the mesial sinus not often seen so well developed, though occasionally present. The specimens collected by us at Nebraska City, include all the varieties assumed by this shell at other localities in the Coal-measures.

Lima retifera Shumard. Fine specimens of the shell referred to this species by Prof. Geinitz, were obtained by us in the division C at Nebraska City, and they agree well with Dr. Shumard's description. The type specimens first described by Dr. S., it will be remembered, were found in Kansas in the Coal-measures associated with *Fusulina cylindrica* and *Productus Nebrascensis*.

Stenopora columnaris Schlot (sp.) Specimens from the divisions B and C at Nebraska City, as well as from various lower positions in the Coal-measures at other localities, agree more or less nearly with some of the supposed varieties figured under this name by Prof. Geinitz in his work on the German Permian fossils. If that species, however, which according to Prof. G. occurs both in the Permian and Carboniferous of the old world, varies to the extent necessary to include all the forms cited in his synonomy, it would appear difficult to determine the extent of its variations, or its geological range.

Synocladia virgulacea (Geinitz, not Phillips; properly *S. biserialis* Swallow). Good examples of this species from division C at Nebraska City, show that the little prominences along the mesial carina of the celluliferous side of the branches, are not generally so elevated as to be properly called even *short* spines. The species, however, differs from *S. virgulacea*, as illustrated and described by King, as already stated, in having properly but two rows of cellules to each branch, instead of from three to five. Nor are these cellules ranged in longitudinal furrows as in *S. virgulacea*. In some instances, in the largest branches, there is an occasional odd cellule near the lateral margins, that cannot be properly regarded as belonging to either of the two rows, but these never form a third or fourth row as shown in *S. virgulacea*. Again, there is always on the Nebraska fossil a single *mesial* longitudinal ridge (usually having minute pores), on the celluliferous side, instead of two, with a mesial row of cells between.

Without going into farther details, I would state that with some two or three exceptions, the lately obtained collections from Nebraska City, and near there include all the species figured by Prof. Geinitz from the beds he refers to the Permian, together with a number of others not collected by Prof. Marcou; and that we now know nearly all these fossils (excepting some seven or eight new species not yet found at any other locality) to be common to these supposed Permian beds and the Coal-measures of Iowa, Illinois, Kansas and Nebraska, where they occur in and beneath, as well as above the very beds referred by Prof. Marcou and Prof. Geinitz, to the Mountain limestone near and above the mouth of Platte river, on the Missouri. In regard to the 7 or 8 new species yet only known from Nebraska City, it may be proper to remark, that with two or three exceptions they are all as nearly allied to Carboniferous as to Permian forms.

In addition to the species figured by Prof. Geinitz, we now know the following other Carboniferous fossils not found here by Prof. Marcou, to occur in the beds he refers to the Upper Dyas at Nebraska City and near there, viz: *Fusulina cylindrica* Fischer, *Terebratula bovidens* Morton, *Orthis carbonaria* Swallow,[*] *Retzia punctulifera* Shumard (= *Terebratula Mormonii* Marcou),

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[*] Prof. Marcou mentioned finding this at Nebraska City, but Prof. Geinitz does not enumerate it amongst the Nebraska City species, but gives Plattsmouth as the locality. It occurs at both places however.

Pecten aviculatus Swallow, (not a true *Pecten*), *Aviculopecten Coxanus* M. & W., *Aviculopecten*, sp. undetermined (common in the Coal-measures of Iowa), and *Pinna peracuta* Shumard; also the following Carboniferous types of fishes, viz: *Ctenoptychius semicircularis* Newberry and Worthen, *Cladodus mortifer* N. & W., *Autliodus* and *Chomatodus* of undetermined species, and another form nearly allied to, or identical with *Deltodus*. We likewise found a fine tooth of *Petalodus destructor* N. & W., so characteristic of the Illinois Coal-measures (referred by Prof. Marcou to the Mountain limestone), in the same beds at Rock-bluff included by him as a part of the Lower Dyas.

It will therefore be seen, that in addition to nearly all of our common Coal-measure *species* of other animal remains, we now know from these supposed Permian rocks of Nebraska and Iowa, the following *genera*, believed to be either exclusively Carboniferous, or not known above the Coal-measures, viz: *Fusulina*, *Erisocrinus*, *Bellerophon*, *Phillipsia*, *Petalodus*, *Cladodus*, *Ctenoptychius*, *Chomatodus*, *Antliodus* and *Cochliodus*; while not a single trace of any peculiarly Permian type of fishes, has ever been found in these rocks.

But it may be proper to mention more precisely the localities and positions at which these Carboniferous types were discovered. In the first place we would state that we found *Fusulina cylindrica* in vast numbers along with nearly all our Coal-measure species at Rock-bluff in the very beds referred by Prof. Marcou to the Lower Dyas. We likewise found this fossil in great numbers 2¾ miles west, and less abundantly at Mr. Morton's place 1¾ west of the Nebraska City landing, associated with the same Coal-measure species, at the elevation of 75 to 80 feet above low water mark of the Missouri; also at Wyoming, 7 miles north, and at Bennett's mill, 3 miles northwest of Nebraska City, all in the same beds referred by Prof. Marcou to the lower part of the Upper Dyas.* *Terebratula bovidens*, *Orthis carbonaria*, *Retzia punctulifera*, *Pinna peracuta*, *Cladodus mortifer*, teeth of *Antliodus* and *Deltodus ?* were all found at Nebraska City in division B of Prof. Marcou's section (the last two by Dr. White of Iowa).

The teeth of *Ctenoptychius semicircularis* were found, one in a shaft at Nebraska City, at near the horizon of Prof. Marcou's division B; another at that horizon by Dr. White at Bennett's mill, and another by the same gentleman at Omaha, in beds referred by Prof. M. to the Mountain limestone. We also found it in beds he referred to the latter horizon at Bellevue. The *Chomadotus* was found by Mr. St. John of the Iowa survey, in the so-called Upper Dyas at Bennett's mill. The same *Phillipsia* figured by Prof. Geinitz from Plattsmouth, and a tooth of a *Cochliodus* have

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* *Fusulina* and other carb. fossils, also occur in an 18 inch bed of limestone one mile below the outcrop at Nebraska City landing, and at a higher geological horizon.

been found in Iowa by Dr. White, in limestone above the horizon of beds containing the same group of fossils characterizing Prof. Marcou's division C at Nebraska City; while *Pecten aviculatus*, and *Aviculopecten Coxanus*, were found in that bed at the last mentioned locality.

From all the foregoing facts, it will be seen, that I am compelled to dissent from the conclusions adopted by Prof. Geinitz, not only in regard to the relations of many of the Nebraska fossils investigated by him to the European Permian species to which he has referred them, but also respecting the age of the rocks from which they were obtained. Of the various species he identifies with foreign Permian forms, there are, it seems to me, not more than some four or five that are so closely similar that no very satisfactory distinction can be detected, from external characters at least. These are the forms he refers to *Nucula Beyrichi*, *Leda Kazanensis*, *Schizodus Rossicus*, *Avicula speluncaria*,*=(*Pseudomonotis*), and *Pleurophorus Pallasi.* The first four of these are, I acknowledge, very similar to the Permian species to which he has referred them, while the fifth seems to be as nearly like *Pleurophorus costatus.* The fact, however, that we know comparatively little of the hinge and interior of these shells, while they are mainly such forms as often present few reliable external characters for specific distinction, and belong for the most part, to genera in which the species are frequently very similar, must weaken our confidence in these specific identifications, under such circumstances. But when we take into consideration the additional fact, that they can all be identified upon quite as good grounds with forms found far down in beds acknowledged by all to belong the Coal-measures, or which have even at some places been referred by Prof. Marcou to the Mountain limestone, and especially when we bear in mind, the numerous unquestionably Carboniferous types with which they are here directly associated in the beds under consideration, the impropriety of basing important conclusions upon them must be apparent.

It may be urged, however, that with the aid of extensive collections of European Permian species for comparison, Prof. Geinitz has had far better facilities for arriving at correct conclusions, in regard to the relations of all of these Nebraska fossils to foreign forms, than can be commanded here. Granting this to be to a considerable extent true (for I have had for comparison a tolerable collection of the more common European Permian species), I must still contend—with all due deference to his deservedly high standing as a geologist—that his peculiar views in

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* The species figured by Prof. Geinitz under this name as elsewhere stated, came from the Permian of Kansas and was not found in Nebraska. He refers to that species, however, specimens from Nebraska City, doubtless the same form we saw at Bennett's mills, and evidently very closely allied to the species *Speluncaria.*

regard to specific and generic distinctions, are such as to materially detract from the value of his paleontological conclusions in a case like that under consideration. The fact that he has unquestionably identified *specifically*, with European forms, several Nebraska fossils belonging to entirely different genera, and in some instances different families, shows conclusively, that if he has kept pace with the recent advances made in conchology and other departments of natural history, he has not, in this instance at least, brought to bear that degree of exactness of discrimination the present state of zoological science shows to be absolutely necessary, before we can hope to arrive at sound conclusions in paleontology.

The necessity for great care in identifying species and genera of shells, has of late years been forcibly illustrated by various anatomical researches, but particularly by the results of the valuable investigations of the lingual dentition of the *Gasteropoda*, made by Loven, Troschel, and others, in Europe, and Dr. Stimpson, Mr. Morse, and others, in this country, by which means forms long regarded as specifically identical have been found to be quite distinct, and so in regard to the genera and higher groups. A case, however, coming more directly home to paleontologists and geologists, is that in which recent microscopical investigations have rendered it probable that a form, until very recently regarded by the highest living authorities as the common *Spirifer cuspidatus* of Sowerby, is not only specifically, but even generically or subgenerically distinct.*

Yet the question may naturally suggest itself, whether, if we admit that only a very few, or even none, of these Nebraska fossils are *absolutely* identical with European Permian *species*, the near affinities of a portion of them to foreign species of that epoch, ought not to be regarded as a sufficient evidence of the contemporaneous age of the rocks from which these were obtained, with those of the Permian of the old world. At a first glance, looking at these Permian types† only, this would certainly seem to be a logical conclusion; and reasoning upon evidence of this kind, Dr. Hayden and the writer actually referred some of these beds on the Missouri to the Permian in 1858, (Trans. Albany Inst., vol. iv.) On afterwards ascertaining, however, that a very large proportion of our most common and characteristic Coal-measure fossils occur in the same beds containing these few Permian types, while the latter, including the so-called *Monotis*, the Bakevellias, *Pleurophorus*, *Schizodus*, &c., are also occasionally met with far below, in unquestionable and acknowledged

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* See Proceed. Acad. Nat. Sci. Philad., Dec. 1865, p. 27; this Journ., May, 1867 and Ann. and Mag. Nat. History for July, 1867.

† By Permian types, I mean forms closely allied to, but not necessarily identical with, Permian species.

Coal-measure strata, we were led to doubt the accuracy of our first conclusion.

These doubts were afterwards confirmed, when on going out into the interior of Kansas, we found there an extensive series of strata, in no way separable from the Coal-measures, containing several of these and a few other Permian types, along with nearly all our common Coal-measure fossils, such as *Fusulina cylindrica*, *Productus longispinus?* (=*Productus Wabashensis* N. & P.), *P. punctatus*, *P. costatus*, *P. Nebrascensis* (=*P. horrescens* of Prof. Geintz's list), *Chonetes mucronata*, *Spirifer cameratus*, *S. planaconvexus*, *Syntrilasma hemiplicata*, *Streptorhynchus crenistria*, the so-called *Orthis Missouriensis*, *Athyris subtilita*, *Naticopsis Pricii*, *Euomphalus rugosus** (Hall not Sowerby), species of *Phillipsia*, and *Bellerophon*, *Petalodus Allegheniensis*, and numerous others that might be mentioned. These we found often mingled in the same beds with the few Permian types, and in other instances in beds alternating with those containing the latter. In ascending several hundred feet higher in the series, we observed the Coal-measure forms gradually dropping off until at last, above a certain undefined horizon, with the exception of one or two of the latter, only Permian forms were observed. Although we regarded these upper beds as the true representatives of the Permian, we gave a section of the whole series, down so as to include a considerable thickness of beds below, with lists of fossils, showing the range of the various types, without drawing any line of demarkation, because we were satisfied nature had no where defined any abrupt physical or paleontological break here in the series. We likewise stated that we believed no geologist, studying these rocks without a knowledge of the classification adopted in the old world, would ever have thought of making any important division here between the Permian and the Coal-measures; and that if the intermediate series containing a mingling of the two types of fossils is to be separated at all from the Coal-measures, we would do it only under some such provisional name as the Permo-carboniferous series.

It will be remembered by those who have read Prof. Marcou's paper on the rocks under consideration, (Bull. Soc. Geol. Fr., 2d ser., xxi, p. 132, 1864), that he referred the Nebraska City beds (including those at Bennett's mill and Wyoming) to the upper Dyas; those at Rock-bluff and Plattsmouth to the lower Dyas, and those above the Platte, at Bellvue, St. Mary's, and Omaha City (erroneously printed Omalia City), to the Mountain limestone. The outcrops at Plattsmouth and Rock-bluff, he thought, con-

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* Since pointing out the differences between this and *Spirorbis planorbitis*, I observe Prof. Geinitz figures under the latter name, in his Dyas, one form with the greatest concavity apparently on the left, another with it on the right side. The quadrangular form of its whorls, and its flattened periphery, however, clearly separates our shell from both of these.

tained the remains of an "eminently New Red Sandstone fauna, approaching, however, the Carboniferous fauna," (ibid, p. 140.)

After examining the fossils collected by Prof. Marcou from these beds, however, Prof. Geinitz refers 30 of the 36 forms composing this so-called "eminently new red fauna" to Carboniferous species, and thinks these rocks hold the position of the upper division of the Carboniferous limestone, or *Fusulina* limestone of Russia and Spain; while the outcrops of Rock-bluff, he thinks, may be considered an upper marine member of the productive coal formation. It is, therefore, only the Nebraska City beds, and those at Mr. Morton's, Bennett's mill and Wyoming, that he refers to the Dyas.

In not admitting the Plattsmouth and Rock-bluff exposures as belonging to the New Red, Prof. Geinitz certainly corrects a grave error of Prof. Marcou's; but if by the words "Carboniferous, or *Fusulina* limestone," he means to place these rocks on a parallel with any part of the Subcarboniferous or Mountain limestone series, as Prof. Marcou has done those above the mouth of the Platte, he falls into as great an error as that he corrects. The evidence of this statement is, the fact that the group of some thirty odd species of fossils found at these localities is *precisely* that characterizing the Coal-measures of Illinois, Iowa, Missouri, and Kansas, and with the exception of four or five species generally considered common to our Coal-measures and the Mountain limestone, they are *all* distinct from the fossils found in our Carboniferous limestones below the Millstone grit.* In addition to this, they are, with three or four exceptions, now known *all* to occur at Nebraska City, Bennett's mills, and Wyoming, in the very beds Prof. Geinitz considers Upper Dyas, along with other Coal-measure species.

It is probable Prof. Geinitz was mainly led to refer the Plattsmouth rocks to the horizon of the *Fusulina* limestone of Russia and Spain, by the occurrence in them of numerous *Fusulina*, and, as he terms it, "the leading genus *Phillipsia*;" since he acknowledges that a large proportion of the fossils found there also occur in the rock he refers to the Dyas. He was, therefore, evidently not aware of the fact that with nearly *all* of the Plattsmouth fossils, countless millions of *Fusulina* also occur in the Rock-bluff section, placed by him in the Coal-measures; as well as (excepting so far as regards the *numbers* of *Fusulina*) in the

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* The following is a list of species known to occur in the Plattsmouth rocks, viz: *Fusulina cylindrica* (in great numbers), *Zeacrinus mucrospinus?*, *Cyathocrinus hemisphericus*, *Productus semireticulatus*, *P. Nebrascensis*, *P. costatus*, *P. Prattenianus*, *P. longispinus*,? *P. punctatus*, *Chonetes mucronatus*, *Streptorhynchus crenistria*, *Syntrilasma hemiplicata*, *Meekella striatocostata*, *Athyris subtilita*, *Rhynchonella Utah*, *Retzia punctulifera*, *Spirifer cameratus*, *Spirifer planoconvexus*, *Sp. lineatus?*, *Spiriferina Kentuckensis*, *Myalina subquadrata*, *M. ampla?*, *Pecten* (??) *aviculatus*, *Aviculopecten occidentalis*, *Pinna peracuta*, *Allorisma subcuneata*, *Bellerophon carbonaria*, *Euomphalus rugosus*, *Nautilus Illinoisensis?*, *Phillipsia* undet. sp.

same beds he and Prof. Marcou include as the inferior member of the Upper Dyas near Nebraska City, at Wyoming and at Bennett's mill. He also ignores the fact, that Prof. Marcou mentions seeing in the Plattsmouth beds, a specimen of the so-called *Monotis*[*] (*Pseudomonotis*), one of the most important types relied upon to prove the divison C, at Nebraska City, a part of the Dyas.[†] Nor does he appear to duly appreciate the fact that there is no *one* limestone in this country, that can be properly termed "the *Fusulina limestone*," for we have numerous *Fusulina* limestones, at various horizons through the whole Coal-measures of Iowa, Missouri, Nebraska and Kansas; while Dr. White finds it and the genus *Phillipsia*, in Iowa, above beds containing the same groups of fossils characterizing the division C at Nebraska City, referred by Prof. Marcou to the Upper Dyas.

Again, in speaking of the Rock-bluff beds as a "*marine* member of the upper productive Coal-measures," Prof. Geinitz seems not to be aware of the fact, that the whole of our western Coal-measures abound in marine fossils, there being no member of our entire Paleozoic series containing a greater profusion of marine types of fossils than the Coal-measures of Nebraska, Kansas, Iowa, Missouri, Illinois, Kentucky, &c. Had he fully understood all of these facts, and the true relations to each other, and to the other Carboniferous rocks in this country, of the several outcrops from which the fossils submitted to him were obtained, there can be no doubt whatever, but he would have arrived at different conclusions from those adopted by him, respecting the age of these rocks, if not in several instances respecting the specific relations of the fossils themselves, to European Permian forms.

After a thorough revision of the whole subject, and a personal examination of all of the exposures mentioned by Prof. Marcou, and numerous others in Iowa, Nebraska and Kansas, not visited by him; as well as after a careful study of extensive additional collections of fossils from these rocks over wide areas, I have no hesitation in reasserting, that all the rocks above the mouth of Platte river referred by Prof. Marcou to the Mountain limestone, and those of Plattsmouth and Rock-bluff placed by him as Lower Dyas, and by Prof. Geinitz, in part on the horizon of the Upper member of the Mountain limestone, and in part in the Upper Coal-measures, as well as those by both of them referred to the Upper Dyas at Wyoming and Bennett's mill and Nebraska City, with *possibly* the exception of divisions C and D at the latter place, belong to the horizon of the Upper Coal-measures. The only point in regard to which there can be any reasonable doubt is, whether the divisions C and D at Nebraska City, belong more prop-

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[*] Bull. Soc. Geol. Fr., II, xxi, 139.

[†] It is well known to occur at even much lower horizons in Kansas.

erly to the horizon of the rocks Dr. Hayden and I termed Permo-carboniferous in Kansas, or to the Coal-measures proper. Or, whether in case it is decided that we *must* draw an arbitrary line somewhere in this region, directly between the Coal-measures and Permian, it may not be thought most consonant with the range of types here to bring down this line, in spite, so to speak, of the various acknowledged Carboniferous forms found in these beds, so as to include the divisions C and D in the Permian.

The great objection however, to the adoption of the latter conclusion, is not only the occurrence of so many unquestionable Carboniferous species in the bed C, at Nebraska City, but the fact that nearly the whole group of fossils found in this bed C at that place, including most of the Permian types, such as the so-called *Avicula speluncaria*, *A. pinnaeformis*, *Schizodus*, *Bakevellia*, *Pleurophorus*, *Leda*, *Nucula*, *Cythere*, &c., also occur in Iowa, beneath others containing nearly all of our most common and characteristic Upper Coal-measure types, and indeed beneath heavy beds of limestone, agreeing in lithological characters, and containing the same groups of fossils found in those on the Missouri referred by Prof. Marcou to the Mountain limestone, as has already been determined by Dr. White (see this Journal, July, 1867, p. 28.)* During my late excursion to the west I had the pleasure of visiting, with that gentleman, some of these localities in Iowa. At one place in Union county, we found directly overlying a bed containing the fossils characterizing division C at Nebraska City, a black fissile shale, containing several specimens of *Aviculopecten rectilaterrea* (*Avicula rectalaterarea* Cox), a species which in Kentucky characterizes the horizon of the ninth coal bed of that State. Immediately above this black shale, in a decomposing limestone with marly partings, we found *Fusulina cylindrica* Fischer, *Spirifer cameratus* Morton, *Spirifer Urii* Flem., *S. planoconvexus* and *Spiriferina Kentuckensis* Shumard, *Orthis carbonaria* Swallow, *Productus Nebrascensis* Owen, *P. longispinus* Sowerby ?, *Chonetes Verneuiliana* N. & P., *Streptorhynchus crenistriata*, *Naticopsis Wheeleri* (=*Littorina Wheeleri* Swallow, a species scarcely distinguishable from *Natica mariæ* M. V. & K., from the Carboniferous rocks of Russia), and the same little *Phillipsia* figured by Prof. Geinitz from Plattsmouth.

At other places in the same region in Iowa, Dr. White has found in the limestones and other beds holding a still higher position, nearly all of the above fossils, and many other Carboniferous types, such as *Meekella striato-costata* (*Plicatula striato-costata* Cox), *Myalina subquadrata* Shumard, *Productus costatus*, *Athyris subtilita*, and numerous *Fusulina*, with teeth of *Cochlio-*

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* It is also well known that in Kansas, beds containing a similar mingling of Permian and Carboniferous types of fossils alternate with others containing almost exclusively Carboniferous forms, through a considerable thickness of strata.

dus, &c. Indeed, Dr. White has already shown that the beds in Iowa, containing the group of fossils found in the division C, at Nebraska City, hold a position about the middle of the Upper Coal-measures in that State (see this Journal for July, 1867.)

I may also add, that our examinations through Iowa, fully and completely confirm Dr. White's statement, that no Subcarboniferous rocks are met with after leaving the outcrops seen along the Desmoines river, in going westward all the way to the Missouri nor along the Missouri, in that State; all this intermediate country being occupied by Coal-measures, excepting some insignificant patches of Cretaceous sandstone. I am aware Prof. Marcou has expressed the opinion that all of the Coal-measures of Iowa, Missouri, Illinois, &c., really belong to the horizon of the Mountain limestone. I can only say, however, that this is done in the face of the indisputable facts, that the fossils of these rocks in Iowa, Nebraska, Kansas and Missouri, differ, as already stated, almost entirely from those of our Subcarboniferous rocks, as every one in this country knows; and agree exactly with what he calls an "eminently new red fauna" at Plattsmouth, while the Coal-measures of Illinois, containing the same fauna characterizing those of the other States named, can be traced without interruption to the southern boundaries of that State, and also into Kentucky, where they are separated from the Subcarboniferous rocks, by from fifty to three hundred or more feet of Millstone grit. In addition to this, it is now generally known that Lesquereux has found the flora of the Coal-measures of Illinois, Kentucky and Indiana, to agree with remarkable exactness, so far as the identity and similarity of species are concerned, with that of the true Coal-measures of Europe.

Indeed, so thoroughly have our western Carboniferous rocks been studied of late years, during the progress of the several State geological surveys; and so completely are the order of succession, thickness, characteristic fossils, &c., of their various subdivisions known, that almost any amateur collector in these districts can instantly decide, from a few corals, crinoids or shells, whether they came from a horizon above or below the Millstone grit. In fact, in a very great majority of cases, a single species would be sufficient to decide this question.

In short, all the facts presented by Prof. Geinitz and Prof. Marcou, when explained by what is known in regard to the geological structure of the country in western Iowa, eastern Kansas, and other neighboring districts of the west, exactly coincide with, and confirm the views published by Dr. Hayden and myself in 1858. That is, that there is in this region, a gradual shading off from an upper Coal-measure to a Permian fauna, through a considerable thickness of strata, forming a somewhat intermediate group which we called the Permo-carboniferous series; also that there is no defined break between this intermediate series, and the Permian above, or the Coal-measures below. Indeed all the phenomena here indicate a gradual change of physical conditions which had probably so nearly approximated those of the Permian in this region, long before the proper close of the Coal-measure period, as to favor the introduction, at certain localities, of some Permian types; while these changes and those following them for a long period of time, running through the interval between the close of the Carboniferous period and the true beginning of the Permian in other parts of the world, where the series seems to be separable into two distinct groups, were not so great as to materially affect the Carboniferous fauna.

Under such circumstances, it must be evident, that all attempts to correlate particular unimportant beds here, with minor subdivisions adopted in Europe, where a different state of things obtained, must necessarily fail; while different opinions will doubtless long exist in regard to the exact horizon in the intermediate series, where the line should be drawn here between the Coal-measures and the Permian. Possibly after much more extensive collections of fossils have been obtained from these rocks, and the vertical range of all of the species has been approximately determined, some more definite conclusions on this point may be arrived at from the percentage of species known to cross certain lines. It is probable, however, that even by this method, the line of division would be found shifting according to the particular parts of the field in which the comparison might be made, for it is evident as we follow the very same beds westward from Iowa and Illinois into Kansas and Nebraska, that the proportion of what would be called Permian types, is found to increase.

In conclusion, I would state, that I hope sometime to have the pleaure of seeing Prof. Geinitz in this country, and of accompanying him to these distant western localities; and although we would doubtless continue to differ upon minor points as to generic and specific distinctions of fossils, I am sure it would not take long to convince so able a geologist as he undoubtedly is, that there is no Mountain limestone within probably more than one thousand feet of the surface on the Missouri in eastern Nebraska, or western Iowa; and that all the rocks referred by Prof. Marcou and himself there to the Subcarboniferous, as well as all they referred to the Permian or Dyas, with *possibly* the exception already alluded to, belong to the Coal-measures.

ART. XXXV.—*Indian Summer;* by JOSEPH E. WILLET, Prof. of Natural Philosophy and Chemistry in Mercer University, Georgia.

A PERIOD of several weeks in Autumn, characterized by smoky atmosphere, equable temperature and cloudless sky, has been known in America as Indian Summer. Several hints as to the cause of this phenomena have been thrown out, but no one of them seems to have been accepted as a sufficient explanation of the facts. The following views have been entertained by the writer for several years, and are presented for the purpose of attracting attention to the subject, with the hope that materials may be collected by observers, the discussion of which may lead to a true theory of Indian Summer.

First, as to the facts.

1. Indian Summer is not confined to North America, but occurs in both hemispheres.

It it so well known in the United States, that no reference need be made to its occurrence here. It is remarkable, however, that it extends on this continent, to very high latitudes.

Sir John Richardson passed the winter of 1848–9 at Fort Confidence, on Great Bear Lake, lat. 66° 54′ N. He remarks,* "with regard to the progress of the seasons, the 'Indian Summer,' as it is called, brought us three weeks of fine weather after our arrival in September."

Kaemtz, in his discussion of the height of the barometer in different seasons, says,† "In the autumn, on the contrary, when the air comes from the south, the south winds predominate; they pour upon the south of Eupope the water with which they are charged, and reach us perfectly dry; hence the beautiful weather, that sometimes prevails in the middle of autumn, and which is known in France under the name of *St. Martin's Summer;* in Germany it is called *the summer of old men*; and in North America, *the Indian Summer.*"

Dr. Livingstone, in his Travels and Researches in South Africa, page 537, when he had arrived at Gonye, lat. 16° 38′ 50″ S., says: "Aug. 22. This is the end of winter. * * * * The whole scenery is lovely, though the atmosphere is murky in consequcnce of the continuance of the smoky tinge of winter. This peculiar tinge of the atmosphere was observed every winter at Kolobeng," (lat. 24° 30′ S.) "but it was not so observable in Londa as in the south, though I had always considered that it was owing to the extensive burnings of the grass, in which hundreds of miles of pasturage are annually consumed. As the

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* Richardson's Arctic Expedition in search of Sir John Franklin, p. 297.

† Complete Course of Meteorology, by L. F. Kaemtz, London, 1845, p. 283.

quantity burned in the north is very much greater than in the south, and the smoky tinge of winter was not observed, some other explanation than these burnings must be sought for. I have sometimes imagined that the lowering of the temperature in winter rendered the vapor in the upper current of air visible and imparted this hazy appearance."

Lieut. J. M. Gilliss, in his very interesting work on Chili,* says, "All through March, and the larger half of April, unexceptionably fine weather lasts, though the atmosphere is less transparent by day than during the other seasons, and copious dews at night show its increasing relative humidity. About the close of the former month, or in the first half of the latter, there are usually from ten to fifteen days when it assumes that peculiar appearance between smoke and dry fog which is so notable as the "Indian Summer" of North America. During its continuance there is scarcely any wind; and, as the temperature after noon rises to summer heat, with its fresh southerly breeze, the air is more enervating than at the latter season. Here the resemblance between the two hemispheres ceases. Unlike the North American "Indian Snmmer," of which, its continuity once broken, there is no return until the following year, the Chilain "verano de San Juan,"† is often interrupted by a renewal of the periodic winds with greater force, or by clouds; and after a day or two, there succeeds another interval, when the air is tranquil and smoky."

In these extracts, we have evidence of Indian Summer in North America, Europe, Africa and South America.

2. Moreover, the indications are, that Indian Summer is a phenomenon of the temperate zone.

I have seen no allusions to it in the writings of travelers in arctic and tropical regions.

As we have seen above, it is distinctly marked in the United States, in Middle Europe, at Santiago in Chili, lat. 33° 26′ 26″ S., and at Kolobeng in South Africa, lat. 24° 30′ S., all within the temperate zone. Sir John Richardson, however, noticed it at lat. 66° 54′ N., just beyond the Arctic Circle, and Dr. Livingstone observed it at Gonye, lat. 16° 38′ 50″ S., about 7° within the torrid zone. The former can scarcely be regarded as an exceptional case, as the observation was made just beyond the Arctic Circle. The latter point is clearly within the torrid zone, but the remarks of Dr. Livingstone show its greater predominance in the temperate. He says "it was observed *every winter* at Kolobeng, (lat. 24° 30′ S.) but it was *not so observable* in Londa" (in which Gonye is situated) "as in the South," and

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* The U. S. Naval Astronomical Expedition to the Southern Hemisphere, vol. i. Chile, page 90.

† St. John's Summer.

that too, notwithstanding, the quantity (of grass) burned in the north (toward the equator) is very much greater than in the south" (toward the Antarctic). If the burnings of the grass were the cause of the smoky atmosphere, then the smokiness should have been more apparent toward the equator; whereas the reverse was so strikingly true, that he abandons his previous notions of a connection, between these burnings and the smokiness, of the nature of cause and effect.

3. The season when it appears and the period of continuance of Indian Summer seem, from the above, to be slightly different in different countries.

In North America, it occurs in September, October, or November in different years. It is sometimes confined to one well-defined period of two or three weeks, as at Fort Confidence, in Sept., and Oct., 1848. But more commonly it is extended through one-half or more of the autumn; presenting a series of smoky days, followed by a period of variable weather, to be restored again in full force for a short time, running thus interruptedly through two months or more. Kaemtz describes its season in middle Europe as "the middle of autumn," but says nothing of its duration.

In the southern hemisphere, Dr. Livingstone recorded his single remark of smoky weather on August 22d, which, with the reversed seasons of that hemisphere, corresponds with our February, but goes on to say, that this peculiar tinge of the atmosphere was observed every *winter* at Kolobeng. This would locate the South African Indian Summer in June, July and August, corresponding to our December, January and February, which period is two or three months later than our Indian Summer. Lieut. Gilliss describes the Chilian Indian Summer as extending "through the close of March and the first half of April," which corresponds with our September and October. From his further description above and from the collection of his register below, the season appears to be more marked and decided than with us.

4. Another point worthy of remark, is that there are individual days of smoky weather, distributed through the whole year and undistinguishable from Indian Summer, in any particular except the time of duration. Were they prolonged for a week or two, we should have Indian Summer in nearly every month of the year, and the phenomenon would cease to be regarded as peculiarly autumnal.

At this place, lat. 33° 37′ N., I have noticed for several years, smoky days in every month, excepting about one month in winter and one in summer. The register by Lieut. A. W. Whipple, U. S. A., of Psychrometric and Climatological observations,* on

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* Report of Explorations and Surveys for a Railroad Route from the Mississippi River to the Pacific Ocean. Senate. Vol. iv, appendix H.

his survey across the western plains from Ft. Smith, Ark., to San Pedro, Cal., presents the same fact. During the several months mentioned below, the whole period of the survey, observations of "smoky," "smoky atmosphere" and "very smoky" are recorded on the following number of days.

1853.	No. of days	1854.	No. of days
Aug.	3	Jan.	1
Sept.	6	Feb.	1
Oct.	10	March	1
Nov.	5		
Dec.	3		

The register of Lieut. J. M. Gilliss at Santiago in Chili is still more conclusive; for no month, observed during the years 1850–1–2, is without "slightly smoky," "smoky" or "very smoky" days. The number of such days in each month will appear in the following table, which has been collected from the Meteorological Observations, vol. vi.

	1850.	1851.	1852.
Jan.	6	9	23
Feb.	7	8	24
March,	21	15	26
April,	18	6	16
May,	5	7	10
June,	4	4	4
July,	5	1	9
Aug.	3	4	9
Sept.	4	3	6
Oct.	2	3	
Nov.	2	2	
Dec.	2	6	

Of like character with these individual smoky days may be the "dry fog" described by Kaemtz, Meteorology, pp. 469–71, as "common in north and west Germany as well as in Holland" and in other parts of Europe. That of 1783 had remarkable intensity and "presented the following phenomena:—its thickness was such, that in some places objects at the distance of five kilometers (3 miles) could not be distinguished; they sometimes appeared blue or else surrounded with vapor. The sun appeared red, and without brilliancy, and could be gazed at in the middle of the day; at its rising and setting, it disappeared in the haze." The fog appeared on different days in different parts of Europe and Asia—at Copenhagen, May 29th; in France and Italy, from the 16th to the 18th of June; in Norway, June 22d; in Switzerland, June 23d; at Stockholm, June 24th; at Moscow, June 25th; toward the end of June in Syria; and the 1st of July in the Altai. In 1834, Kaemtz noticed others in May, July and August; the one of May seemed to be transferred from place to place by violent N. E. winds. In these countries (Germany and Holland) the dry fog is coincident with the burning of peat; when the air is dry, the smoke remains suspended in the atmosphere and may be carried away by the winds. The wind always blows from the direction of the peat bogs, when dry fog is manifested; and fogs have frequently been seen coming distinctly from the peat bogs." "The very thick dry fog of 1834 came partly from the combustion of peat, and partly from the fires for which this year was noted." "To the same cause, probably, may be attributed the particular aspect of the air in autumn. In the fine days, when the air is very dry, the air is less transparent; distant objects are not seen distinctly, they appear surrounded by a slight fog." "Can the dry fog of 1783, which was diffused over a great portion of Europe, be attributed to the same cause?" Popular superstition in Europe attributes to this "dry fog" "the disease of smut in corn, and diseases in vegetables generally," and "the predominance of the north winds which then prevail, and they say that it drives away rain and storms, and is a cause of cold."

The above description of "dry fog" accords very well with the appearance of many occasional smoky days in this country, which, if they occurred in autumn, would be styled Indian Summer. Relying upon the description alone, I am inclined to class them together. Kaemtz, also, in the description above, of "the particular aspect of the air in autumn," seems to allude to the German Indian Summer, and thus connects together the phenomena of dry fog and Indian Summer.

So much for the facts, let us now turn to the theory of Indian Summer.

Any theory, to be complete, must equally apply to these occasional smoky days, which are distributed throughout the year; for these present exactly the same characteristics, and are noted by observers, as Lieut. Whipple and Lieut. Gilliss, in precisely the same terms, as the groups of autumnal days, commonly called Indian Summer.

Without alluding to previous theories on the subject, I suggest the following:

1. The smokiness is produced by real smoke, proceeding from the ordinary fires employed in preparing food, etc., or from extraordinary fires in the burning of grass, brushwood, etc. This is an evident and a sufficient cause, and it is unphilosophical to seek for others, until this is shown to be inadequate to the given effect.

Moreover, Kaemtz, as above, plainly ascribes the smokiness of "dry fogs" to the smoke from peat bogs. What is more to the point, Prof. Henry, in allusion to "dry fogs," remarks;*

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* Patent Office Report. Agriculture. 1858, pp. 458–9.

"The nature of these fogs is now pretty well understood, and more refined observations, particularly with the microscope, have served to dissipate the mystery in which they were formerly enshrouded. When a portion of the air in which the fog exists is filtered, as it were, through water, and the substance which is retained, is examined by the microscope, it is found to consist of minute fragments, in some cases, of burnt plants, and in others of the ashes of volcanoes." "Samples of substances which have been collected from rain water and examined microscopically by Prof. Schaeffer, of Washington, at the request of the Smithsonian Institution, have been found to consist of portions of plants, which must have come from a great distance, since the species to which they belong are not found in abundance in the localities at which the specimens were obtained. It is highly probable that a portion of the smoke or fog-cloud produced by the burning of one of our western prairies is carried entirely across the eastern portion of the continent to the ocean." In reference to Indian Summer, Prof. Henry remarks, "Though the first announcement of the proposition by some of our earlier meteorologists, that the peculiar condition of the atmosphere known as Indian Summer might be produced by the burning of the prairies, was not thought worthy of any comment, yet the advance of science in revealing the facts I have stated, renders this hypothesis by no means unworthy of attention."

Although these extraordinary fires may furnish the smoke for extraordinary manifestations of smokiness as in "dry fog" or unusually dense Indian Summer, yet I think too little importance has been attached to the smoke from ordinary fires. Immense volumes of smoke ascend daily from these, and it is not improbable that the majority of smoky days derive their smokiness from these ordinary sources.

2. Atmospheric currents, subsiding from higher to lower regions, would produce smokiness by depressing the smoke, and by coming under greater pressure would become relatively dry, and would thus produce relative dryness and equableness of temperature during their continuance.

Every meteorologist has, doubtless desired an indicator or vane for descending currents. Can any be devised more sensitive than smoke? The direction of horizontal currents is constantly determined by the swaying wreaths of smoke from chimneys. If the rising columns of smoke remain suspended in the lower atmosphere and hang like a smoky veil over the whole landscape, why may not the phenomenon be referred to descending currents of air? Why not follow the indications of the vane? If the smoke bends toward the north, east, south, or west, we attribute it to a wind from the opposite quarter. If it bends toward the earth, why not attribute it to a current from above? Mainly from the fact, that we are less familiar with descending currents, and that from the want of an indicator, we know less of their habitudes.

3. This subsiding of atmospheric currents may occur at any time, when circumstances favor; but it will be most apparent, when a conjunction of circumstances render them continuous through a series of days, as in the autumn.

Hence smoky days may occur in every month of the year, and a succession of them is called Indian Summer—near the autumnal equinox, when the violent disturbing elements of summer heat and winter cold are at a minimum. The vernal equinox would seem to be equally favorable with the autumnal; but, in the former case, a hemisphere cooled by the winter's cold and heating up under the advancing warmth of the season may be less favorable to a stable equilibrium of the atmosphere, than the same hemisphere heated by summer and cooling by radiation during the autumn.

4. Descending currents of air are supposed to occur most in the temperate zones, and Indian Summer seems to be a phenomenon of the same zone.

Kaemtz seems to think that the trade winds return toward the poles as an upper current and settle to the earth about lat. 30° and thence flow as a surface current toward the poles, returning to the equator by some route not well indicated. American meteorologists* think that the atmosphere of a hemisphere is divided into three systems, with upper and lower currents, and with belts of rains or of calms where the systems meet. But all agree as to the descent of the upper currents, whether from the equator or from the poles, to a greater or less extent, over the temperate zone and these may, when other circumstances favor, depress the smoke and produce Indian Summer.

In the above discussion, I have attempted to show that Indian Summer, the occasional smoky days distributed throughout the year, and probably dry fog are similar if not identical phenomena, and attributable to the same cause; that the smokiness is due to ordinary smoke derived from the ordinary or extraordinary fires of a country; that the smoke is held suspended in the lower portions of the atmosphere by descending currents of air; and, finally, that the phenomena seem to prevail most in autumn and in the temperate zones, and the descending currents originate in the subsidence toward the earth of the upper currents from the equator or from the poles.

In conclusion, it is proper to say, that, by examination of the

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* See an able paper on the subject by Prof. Henry, Patent Office Report. Agriculture, pp. 471–7. Also Maury's Physical Geography of the Sea. Also a paper by W. Farrel, this Journal, II, xxxi, No. 91.

only complete register, that of Lieut. Gilliss, in my possession, I have not been able to connect the views here presented with the indications of the barometer. This was hardly to be hoped for, from a single register, at one locality.

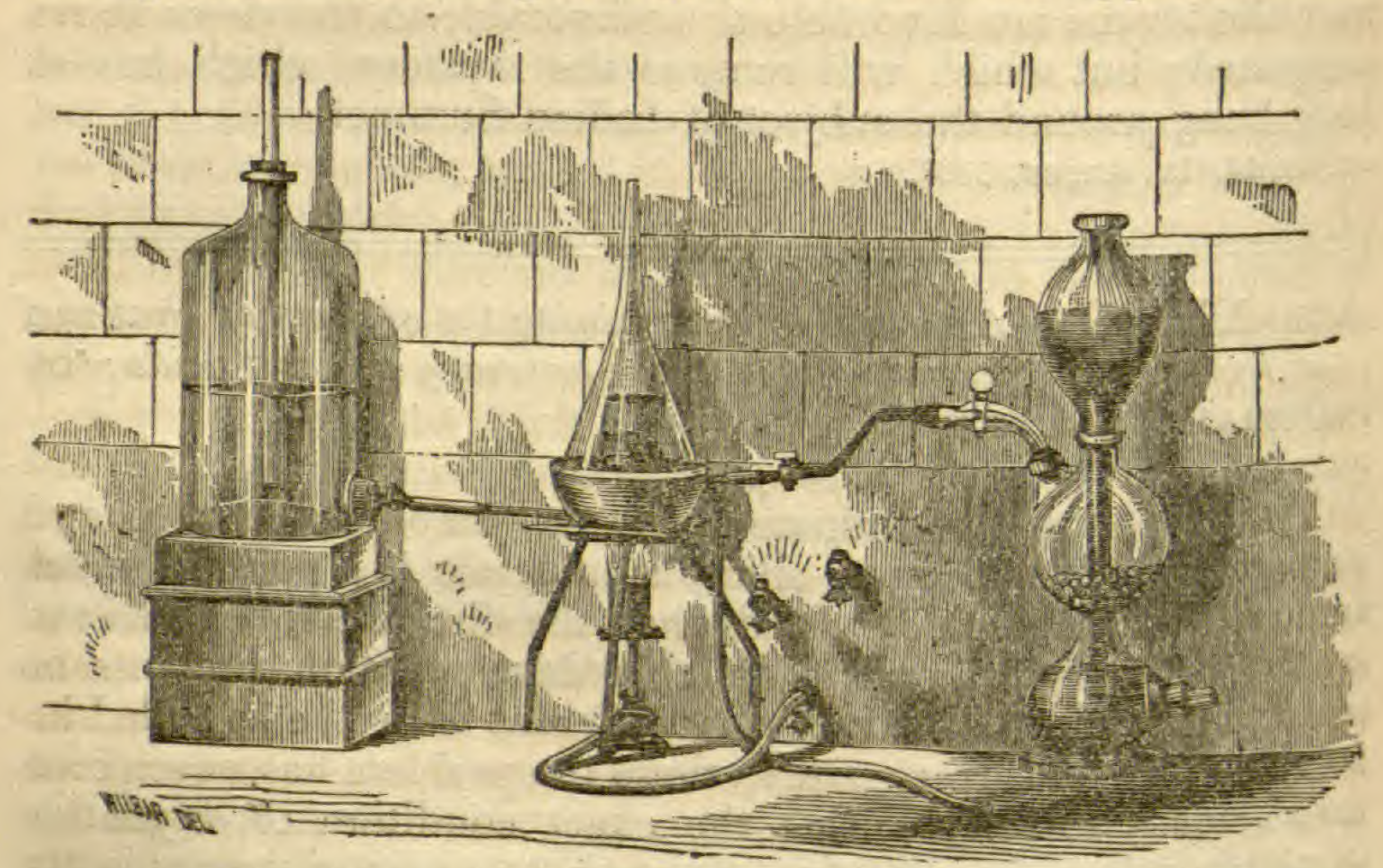
Indian Summer prevails over a large extent of territory, and its laws must be evolved by the discussion of many registers kept at places distributed over the whole territory. Smokiness is rarely recorded by observers among the phases of the sky, and hence previous registers throw little light upon the subject. Should the attention of observers, hereafter, be directed to this phase, the mass of observations thus obtained may show whether the phenomena are simultaneous or consecutive over a large extent of country; whether the barometer rises or falls, &c.; and may elicit some law favorable or unfavorable to the views above suggested; but which will remove the mystery, which has so long hung around the subject of Indian Summer.

Penfield, Ga., August, 1867.

ART. XXXVI.—*A method of determining the amount of Protoxyd of Iron in Silicates not soluble in the ordinary mineral acids;* by JOSIAH P. COOKE, Jr.

THE accurate determination of the amounts of protoxyd and sesquioxyd of iron in siliceous minerals is a point of much importance in mineralogy, and when the silicate can be dissolved by the ordinary mineral acids, this determination presents no great difficulties. But it is very different with the so-called insoluble silicates. In regard to these the problem has never been satisfactorily solved; so that the exact condition of oxydation of the iron in some varieties of the most common species is not with certainty known. Many siliceous minerals which are not perfectly decomposed by the dilute mineral acids in an open vessel, are dissolved after long digestion in a sealed flask, and in a former paper the author described a simple and accurate method of determining the amount of protoxyd of iron in all silicates of this class. The method here described applies chiefly to the silicates, which cannot be thus decomposed and is based on the use of hydrofluoric acid as a mineral solvent. With a very few exceptions all silicates are dissolved after a more or less prolonged digestion in a mixture of sulphuric and hydrofluoric acids, and in this solution the amount of protoxyd of iron can be accurately determined with permanganate of potassa. It is of course essential that the solution should be made out of contact with the air and the difficulty of fulfilling this condition with hydrofluoric acid has probably been the reason why this valuable reagent has not been hitherto used in iron determinations. This difficulty however may be completely overcome by the apparatus represented in the accompanying figure which, although it may appear complicated at first sight, is really a simple combination of parts, which are familiar in every laboratory.

To the sides of a common copper water bath are attached three tubes as is shown in the figure. The tube on the left connects with a Mariotte's flask by which the water is maintained at a constant level in the bath. The upper tube on the right connects with a carbonic acid gas generator, while the lower tube (connected with the sink by a rubber hose), serves simply as an overflow for the water. On the cover of the water-bath close to the rim is a depressed circular groove, which receives the lip of an inverted glass tunnel. When the apparatus is in use this groove is kept full of water by the spray from the boiling liquid and thus forms a perfect water joint; but in order to secure this result the bath must be kept nearly full of water and holes for the ready escape of the steam and spray should be provided in the copper rings, which cover the bath and adapt it for vessels of various sizes. It is evident that, by this simple modification of the ordinary water-bath, we can keep our assay surrounded by an atmosphere of steam or of carbonic acid, as may be desirable, during the whole process of digestion, and that too for an indefinite period. Moreover while watching the process through the glass we can either pour in fresh quantities of the solvent, or we can stir up the material, in the vessel within, introducing a tube-tunnel or stirrer through the spout of the covering tunnel.



After the above description the method of making the iron assay will be readily understood. A small amount of the finely pulverized mineral (from one-half a gram to a gram) is weighed out in a large platinum crucible. Upon this we pour a mixture of dilute sulphuric acid (sp. gr. 1·5) with as little hydrofluoric acid as experience may show is required to dissolve* the mineral stirring up the material with a platinum spatula. The crucible is next transferred to the water bath, the covering tunnel put in place, water poured into the groove, the interior filled with carbonic acid from the generator and the gas lamp lighted. As soon as the water boils, the connection with the generator is closed, and if the water level has been properly adjusted, the apparatus will take care of itself, the groove will be kept full of water and the interior of the tunnel full of steam. If the materials cake on the bottom of the crucible,—as is not unfrequently the case when a large amount of insoluble sulphate is formed,—the lamp may be removed, the apparatus again filled with carbonic acid, and the contents of the crucible stirred up as above described. A stout platinum wire about two inches long, cemented before the blowpipe to the end of a glass tube, makes an excellent stirring rod, and after using it any adhering material can easily be washed back into the crucible by directing the jet from the wash bottle down the throat of the covering tunnel. The lamp may then be replaced, the current of carbonic acid interrupted and the process of digestion continued. When the decomposition is complete the current of carbonic acid gas is reëstablished, the lamp extinguished and the air tube of the Mariotte's flask raised until its lower end is above the level of the overflow. A slow current of water is thus caused to flow through the bath, which soon cools down the whole apparatus. The crucible may now be removed, its contents washed into a beaker glass and the solution diluted with pure water until the volume is about 500 $\overline{\text{c.m.}}^3$, when the amount of protoxyd of iron present can be determined with a solution of permanganate of potassa in the usual way. The total amount of iron present being subsequently determined, the relative proportion of the two oxyds is of course well known. In order to show the accuracy of the method and also to prove that the presence of hydrofluoric acid does not exert any appreciable influence on the permanganate solution we subjoin the following results.

The strength of the solution of permanganate was tested with the double sulphate of ammonia and iron. In each case 1·4 grams of the salt were accurately weighed out and dissolved in about 500 $\overline{\text{c.m.}}^3$ of water. To the first two portions sulphuric acid was alone added while to the last two there was also added a very large amount of hydrofluoric acid, four or five times as

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* If the mineral contains lead, baryta, strontia or even lime in any considerable quantity, complete solution cannot of course be obtained, but this is unimportant so long as the mineral is wholly decomposed.

much as would be required in any mineral analysis. The results were

No. 1, 1·4 grams iron salt required 26·35 $\overline{\text{c. m.}}^3$ permanganate.
No. 2, " " " " " 26·35 " "
No. 3, " " " " " 26·4 " "
No. 4, " " " " " 26·45 " "

From a specimen of very dark green actinolite treated as above described we obtained in three determinations the following results.

No. 1, 0·6913 grams of mineral required 14·1 $\overline{\text{c. m.}}^3$ permanganate.
No. 2, 0·6640 " " " " 13·6 " "
No. 3, 0·8910 " " " " 18·2 " "

The per centage composition deduced from this is

	Per cent of FeO.
No. 1,	19·86.
No. 2,	19·95.
No. 3,	19·89.

In order to test still further the efficiency of our apparatus we have several times dissolved 2 decigrams of iron in dilute sulphuric acid and heated the solution in the bath for more than twelve hours without its undergoing the slightest oxydation.

It is of course essential in this process that both the sulphuric and hydrofluoric acids should be perfectly pure and wholly free from any oxydizing or reducing agents. There is no difficulty in obtaining from the manufacturers pure sulphuric acid, but unfortunately the commercial hydrofluoric acid is apt to be very impure and must be carefully purified by repeated distillation before it is used in this process. The apparatus here described will also be found very useful in the ordinary iron assays and is also applicable in a large number of analytical processes, where it is necessary that the assay should not be exposed to the air. Of course in such cases a glass beaker would take the place of the platinum crucible, as is shown in the figure. Lastly, this method of heating in an atmosphere of steam will be found very convenient in the many cases where it it is desirable to prevent the evaporation of water during the process. The presence of the steam moreover, prevents to a great degree the escape of the volatile acids; so that in the process above described, the glass covering tunnel is not perceptibly corroded unless the hydrofluoric acid used is very strong.

Cambridge, June 22d, 1867.

ART. XXXVII.—*The Parks of Colorado.*

[THE "San Luis Park" of Colorado, in which the Rio Grande del Norte takes its rise, has recently been described by an anonymous writer, reported on good authority to be Hon. Mr. Gilpin, late Governor of Colorado. This description is so graphic and minute, and exhibits so good an acquaintence with a region which has been but little investigated, that we are led to reprint it from the ephemeral pages in which it has appeared.—EDS.]

The San Luis Park.—The San Luis park is readily entered at the extreme north through the Poncho pass, penetrating the Cordillera from the Arkansas river. This park, of elliptical form and immense dimensions, is enveloped between the Cordillera and Sierra Mimbres. It has its extreme northern point between these two Sierras, where they separate by a sharp angle and diverge: the former to the southeast, the latter to the southwest. The latitude of the Poncho pass is 38° 30′, the longitude 106°. It is one hundred and twenty-five miles southwest from Denver, and thirty-seven miles due west from Canyon City.

Emerging from the Poncho pass, the waters begin to gather and form the San Luis river. This flows to the south through a valley of great beauty, which rapidly widens to the right and left. On the east flank the Cordillera ascends abruptly and continuously, without any foot hills, to a sharp, snowy summit; on the west, foot hills and secondary mountains, rising one above the other, entangle the whole space to the Sierra Mimbres.

The Sawatch river has its source on the inner (eastern) flank of the Sierra Mimbres, about sixty miles south of its angle of divergence from the Cordilleras, and by a course nearly east converges toward the lower San Luis river. It enters upon the park by a similar valley. These two valleys expand into one another around this mass of foot hills, fusing into the open park, whose center is here occupied by the San Luis lake, into which the two rivers converge and discharge their waters.

The San Luis lake, extending south from the point of the foot hills, occupies the center of the park for sixty miles, forming a bowl without any outlet to its waters. It is encircled by immense saturated savannas of luxuriant grass. Its water surface expands over this savanna during the season of the melting snows upon the Sierras and shrinks when the season of evaporation returns. From the flanks of the Cordillera on the east, at intervals of six or eight miles asunder, and at very equal distances, fourteen streams, other than the San Luis, descend and converge into the San Luis lake. The belt of sloping plain between the mountains and the lake, traversed by so many parallel streams, bordered by meadows and groves of cottonwood trees, has from this feature the name "Los Alamosos." It is sixty miles in length and twenty wide. On the opposite (western) side, from the flank of the Sierra Mimbres, similar streams, known as the Sawatch, the Carnero, and the Gareta, descend from the west into the lake.

The confluent streams thus converging into the San Luis lake are nineteen in number. The area thus occupied by this isolated lake and drained into it by its converging affluents, forming distinctly the northern section of the park, and being one-third of its whole surface, is classified under the general name of "Rincon."

Advancing onward to the south, along the west edge of the plains, ten miles from the Gareta, the Rio del Norte issues from its mountain gorge. Its source is in the perpetual snows of the peaks of San Juan, the local name given to this stupendous culmination of the Sierra Mimbres. The Del Norte flows from its extreme source due east one hundred and fifty miles, and having reached the longitudinal middle of the park turns abruptly south, and bisecting the park for perhaps one hundred and fifty miles, passed beyond its rim in its course to the Gulf of Mexico. All the streams descending from the enveloping Sierras (other than the Alamosos) converge into it their tributary waters. On the west come in successively the Pintada, the Rio del Gata, the Rio de la Gara, the Conejos, the San Antonio, and the Pieda. These streams, six or eight miles asunder, parallel, equidistant, fed by the snows of the Sierra Mimbres, have abundant waters, very fertile areas of land, and are all of the very highest order of beauty.

Advancing again from the Rincon, at the eastern edge of the plain along the base of the Cordillera, the prodigious conical mass of the Sierra Blanca protrudes like a vast hemisphere into the plain and blocks the vision to the direct south. The road describes the arc of a semi-circle around its base for thirty miles, and reaches Fort Garland.

In the immediate vicinity of Fort Garland, the three large streams, the Yuta, Sangre de Christo, and the Trenchera, descend from the Cordillera, converge, unite a few miles west, and blending themselves in the Trenchera, flow west twenty-four miles into the Rio del Norte. The line of the snowy Cordillera, hidden behind the bulk of the Sierra Blanca, here again reveals itself pursuing its regular south-southeast course and direction. Fourteen miles south is reached the town of San Luis, upon the Calebra river; seventeen miles further is the town of Costilla, upon the Costilla river; fifteen miles further the town of Rito Colorado is reached; eighteen miles onward is the Arroyo Hondo; (between these is the San Cristova;) from the Arroyo Hondo to Taos is fourteen miles; twenty miles beyond Taos is the mountain chain whose circle toward the west forms the southern mountain barrier which encloses the San Luis park in that direction.

The San Luis park is then an immense elliptical bowl, the bed of a primeval sea which has been drained; its bottom, smooth as a water surface and concave, is 9,400 square miles in area. It is watered by thirty-five mountain streams, which, descending from the encircling crests of snow, converge, nineteen into the San Luis lake, the rest into the Rio del Norte. An extraordinary symmetry of configuration is its prominent feature. The scenery, everywhere sublime, has the everchanging variety of the kaleidoscope. Entirely around the edge of the plain, and closing the junction of the plain with the mountain foot, runs a smooth glacis, exactly resembling the sea beach, which accompanies the conjunction of the land with the ocean. From this beach rise continuously all around the horizon the great mountains, elevating their heads above the line of perpetual snow. On the eastern side the escarpment of the Cordillera rises rapidly, and is abrupt; on the western side the crest of the Sierra Mimbres is more remote, having the interval filled with ridges, lessening in altitude as they descend to the plain of the park. This continuous shelving flank of the Sierras, completing a perfect amphitheater, has a superficial area equal to that of the level plain which it envelops, and gives to the whole enclosure within the encircling band of snow an area of 18,000 square miles. At an elevation of five or six thousand feet above the plain a level line upon the mountain wall marks the cessation of arborsence, above which naked granite and snow alone are seen. To one who ascends to this elevation at any point, the whole interior of this prodigious amphitheatre is scanned by the eye and swept in at a single glance. Aided by a glass, the smallest objects scattered over the immense elliptical area beneath are discernible through the limpid, brilliant, and translucent atmosphere. Two facts impress themselves upon the senses: the perfect symmetry of configuration in nature and the intense variety in the forms and splendor of the landscape. The colors of the sky and atmosphere are intensely vivid and gorgeous; the dissolving tints of light and shade are forever interchanging; they are as infinite as are the altering angles of the solar rays in their diurnal circuit.

The average elevation of the plain above the sea level is 6,400 feet. The highest peaks have an altitude 16,000 feet above the sea. In the serrated rim of the park, as seen from the plain, projected against the canopy, are discernable seventeen peaks, at very equal distance one from another. Each one differs from all the rest in some peculiarity of shape and position. Each one identifies itself by some striking beauty. From the snows of each one descends some considerable river, as well within the park as outward down the external mountain bank.

We recognize, therefore, in the San Luis Park an immense elliptical basin enveloping the sources of the Rio Bravo del Norte. It is isolated in the heart of the continent, twelve hundred miles from the sea. It is morticed, as it were, into the midst of the vast mountain bulk, where, rising gradually from the oceans, the highest altitude and amplitude of the continent is attained. This park spreads it plain from 36° to 38° 30′, and is bisected by the 106th meridian. Its greatest length is 210 miles; its greatest width is 100; its aggregate approximate area is 18,000 square miles.

Such being the geographical position, altitude, and peculiar unique configuration, these features suggest the inquiry into parallel peculiarities of meteorology, geology, physical structure, agriculture, mineralogy, and the economy of labor.

The American people have heretofore developed their social system exclusively on the borders of the two oceans, and within the maritime valleys of moderate altitude, having navigation and an atmosphere influenced by the sea. To them, then, the contrast is complete in every feature, in these high and remote altitudes beyond all influence of the ocean, and specially continental.

There is an identity between the "Valley or Park of the City of Mexico" and the San Luis park which ought to be here mentioned. They are similar, twin basins of the great plateau, classifying together and alike in the physical structure of the continent. Mexico is in latitude 20°, longitude 99°, and at 7,500 of altitude. The width of the continent is here 575 miles (from ocean to ocean,) and the divergence of the Cordilleras is 275 miles, which is here the width of the plateau. At the 39° the continent expands to a width of 8,500 miles between the oceans; the Cordilleras have diverged 1,200 miles asunder, and the plateau has widened the same dimensions. In harmony with this great expansion of the continent are all the details of its interior structure. The "Park of the City of Mexico" is but one-tenth in size and grandeur as compared and contrasted with the San Luis park. Of identical anatomy, the former is a pigmy, the latter a giant. The similtude as component parts of the mountain anatomy is in all respects absolute, as is also true of the other parks, which occupy longitudinally the center of the State of Colorado.

Meteorology.—The atmospheric condition of the San Luis park, like its scenery, is one of constant brilliancy, both by day and night, obeying steady laws, yet alternating with a kind of playfully methodical fickleness. There are no prolonged vernal or autumnal seasons. Summer and winter divide the year.

Both are characterized by mildness of temperature. After the autumnal equinox the snows begin to accumulate upon the mountains. After the vernal equinox they dissolve. The formation of light clouds upon the crest of the Sierras is incessant. The meridian sun retains its vitalizing heat around the year; at midnight prevails a corresponding tonic coolness. The clouds are wafted away by the steady atmospheric currents coming from the west. They rarely interrupt the sunshine, but refracting his rays, imbue the canopy with a shining silver light, at once intense and brilliant. The atmosphere and climate are essentially continental, being uninterruptedly salubrious, brilliant, and tonic.

The flanks of the great mountains, bathed by the embrace of these irrigating clouds, are clad with dense forests of pine, fir, spruce, hemlock, aspen, oak, cedar, pinon, and a variety of smaller fruit trees and shrubs, which protect the sources of springs and running rivulets. Among the forests alternate mountain meadows of luxuriant and nutritious grasses. The ascending clouds, rarely condensed, furnish little irrigation at the depressed elevation of the plains, which are destitute of timber, but clothed in grass. These delicate grasses, growing rapidly during the annual melting of the snows, cure into hay as the aridity of the atmosphere returns. They form perennial pastures, and supply the winter food of the aboriginal cattle, everywhere indigenous and abundant.

An infinite variety in temper and temperature is suggested as flowing from close juxtaposition of extreme altitudes and depressions; permanent snows, running rivers, and the concentric courses of the mountains and rivers. Storms of rain and wind are neither frequent nor lasting. The air is uniformly dry, having a racy freshness and exhilarating taste. A soothing serenity is the prevailing impression upon those who live perpetually exposed to the seasons. Mud is never anywhere or at any time seen. Moderation and concord appear to result from the presence and contact of elements so various.

The critical conclusions to which a rigid study of nature brings the scrutinizing mind are the reverse of first impressions. The multitudinous variety of nature adjusts itself with a delicate harmony which brings into healthy action all the industrial energies. There is no use for the practice of professional pharmacy. Chronic health and longevity characterize animal life. The envelope of cloud-compelling peaks, the seclusion from the oceans, the rarity of the air inhaled, and the absence of humidity disinfect the earth, the water, and the atmosphere of exexhalations and miasmas. Health, sound and uninterrupted, stimulate and sustain a high tone of mental and physical eneryg. All of these are banished, as it were, by the perpetual brilliancy and salubrity of the atmosphere and landscape, whose unfailing beauty and tonic taste stimulate and invite the physical and mental energies to perpetual activity.

Geology and Minerals.—As a geological basin, the San Luis park is in the highest degree interesting and remarkable. It is found to contain, intermingled and in order, a complete epitome of all the elements of which geological science and research take note. Its intra-mural locality between the primeval crests of the Cordillera, on the east, and the Sierra Mimbres, (here called the "San Juan,") on the west, multiplies this variety indefinitely. These primary Sierras, separated by the park, face one another in full sight, as they rear their flanks from the opposite edges of the concave plain. The successive periods and stupendous forces which have expended themselves to produce what is in sight, and then subsided to an eternal rest, each particularly manifest itself. The comb of the Sierra presents the prodigious plates of primeval porphyry driven up, as the subsoil of a furrow, from the lowest terrestrial crust and protruding their vertical edges toward the sky.

This summit yielding to the corroding forces, presents a wedge toward the canopy; is arranged in peaks resembling the teeth of a saw; is above all arborescence, and is either clad in perpetual snow, or is bald rock.

Against this is lapped perpendicularly the second stratum, less by many thousand feet in altitude, its top forming a brim or bench. This bench, being the rended edge of the erupted stratum, softer than the first and receiving the debris from above, has a deep, fertile soil, a luxuriant alpine vegetation, forests of fir and aspen, and is the highest region of arboresence and vegetable growth.

This is the region of rocks where the metals, especially gold and silver, abound in crevices charged and infused with the richest ores. It is from hence that the gold of the gulches is disintegrated and descends. Here are springs of water and and the sources of rivers. The timber is excellent and the pastures of various grasses luxuriant and inexaustible. Swept by ascending currents of vapor, irrigation is constant. This elevated bench is a permanent characteristic of the mountain flank, continuous as the continent itself; a collossal staircase whose steps are themselves of mountain magnitude. It is here, at these surfaces of contact of the erupted plates of the lowest terrestrial crust, that the thread of the "gold belt" is revealed and found. From this thread, as from a core outward, the precious metals taper in quantity and become diluted in the immensity of the rocks, as a hill of rock salt disappears to the eye, dissolved in the immensity of the ocean.

The top of this continuous bench is undulating, broad, and occasionally crossed by transverse ridges and the chasms of water-courses. The front flank of this bench forms the stupendous escarpment of the mountains, everywhere lofty and precipitous. It is cut through by innumerable streams, up whose gorges access to the upper regions is attained, and the internal contents, the intestines, as it were, of the rocks are revealed to sight and search.

Forming the pediment of this stupendous mural escarpment is the second brim or bench (being the lowest) in the general mountain descent. Here the approaching elevation of the plain, the increase in size of the streams, the accumulating debris from above, and the increased atmospheric abrasion, all unite to obliterate the angularity of the rocks and impair the striking distinctness of formation. Forests of pine and deciduous trees prevail. The flora and vegetation is abundant and various. The atmospheric irrigation becomes uncertain, and the rocks are covered with soil or the fragments of their own superficial destruction. Immediately following is the broad space occupied by the fusion of the mountain base and the plain gently descending to meet it. Here is a profile infinitely indented and broken; alternately the sloping ridges protrude their ribs into the plain, and the plain advances its valleys between them to receive the streams. This is the region of the placers, where is checked in its descent and lodged beneath the alluvian soil the free gold washed down by torrents from the overhanging summits.

This sketch of the normal structure and configuration of the Cordillera is illustrated by a chequered list of details in its minute elements. The primeval rocks, heated to incandescence, rest in their vertical positions unaltered from their original form; they have been roasted but not liquified. Original strata of limestone and gypsum, uplifted on high but not destroyed, rest upon the summit as a torn hat. Gypsum, limestones, slates, clays, shales, are thus found near the highest summits. The decay of the secondary rocks gives extraordinary fertility to the mountain flanks and to the alluvial bottoms below. Hence the luxuriance of the arborescence, the pastures, and the flora. The altitude of the summits gathers and retains the snows, whose glaciers give birth to innumerable rivers. These gash the precipitous flanks with chasms, up which roads ascend; the composition of the rocks is here revealed; the mysteries of their interior contents are unravelled, and the secretions of nature subjected to the human eye and hand.

Thus, then, erects itself the primeval Cordillera, constructed of horizontal plates, vertically thrown up by stupendous volcanic forces, partially altered or roasted by incandescent heat, but neither destroyed nor recast in form; the secondary rocks are tossed and scattered high in the upper regions, but are not calcined by flame. The metallic ores are as various as is the variety of the rocks, enriched by heat and exposed by upheaval and corrosion. No lava, no pumice, no obsidien, nothing of melted matter from the plutonic region is seen. This furrowing of the terrestrial crust has alone occupied and exhausted the stupendous volcanic throes of the subterranean world of fire.

Sierra Mimbres.—The Sierra Mimbres, forming the western envelope of the park, is not dissimilar to the Cordillera in its origin, composition, and configuration. Rising from the level of the great plateau, it is of inferior bulk and rank. It forms the backbone from whose contrasted flanks descend the waters of the Rio del Norte on the east, and of the Colorado on the west.

Craters of extinct volcanoes are numerous; streams of lava, once liquid, abound; pedrigals of semi-crystalline basalt submerge and cover the valleys into which they have flowed, and over which they have hardened.

This Sierra, then, has a general direction from north to south, corresponding with the 109th meridian. It has all the characteristics in miniature of the Cordillera, but is chequered and interrupted by the escape of subterranean fires, having areas overflowed and buried beneath the erupted current. Where the nascent springs of the Rio del Norte have their birth, the Sierra Mimbres culminate to stupendous peaks of perennial snow, locally named Sierra San Juan.

The concave plain of the San Luis park, begirt by this elliptical zone of the Sierras, thus capped with a ragged fringe of snow projected upward against the canopy, is the receptacle of their converging waters. It is a bowl of vast amplitude, which has for countless ages received and kept the sedimentary settlings of so prodigious a circuit of Sierras, builded up with every variety of form, structure and geological elements elsewhere found to enter into the architecture of nature. Hither descend the currents of water, of the atmosphere, of lava. The rocks rent from the naked pinnacles, tortured by the intense vicissitudes which assail them; the fragments rolled by the perpetual pressure of gravity upon the descending slopes; the sands and soils from the foundations of rocks and clays of every gradation of hardness; the humus of expired forests and annual vegetation; elements carbonized by transient fires; organic decay; all these elements descend, intermingle, and accumulate.

This concave plain is, then, a bowl filled with sedimentary drift, covered with soil and varnished over as it were with vegetation. The northern department or Rincon, closely embraced by the Sierras and occupied by the San Luis lake, is a vast savanna deposited from the filtration of the waters, highly impregnated with the mountain debris. Beneath this soil is a continuous pavement of peat, which maintains the saturation of the super-soil, and is admirable for fuel.

The middle region of the plain, longitudinally, displays a crater of the most perfect form. The interior pit has a diameter of twenty miles, from the center of which is seen the circumferent wall forming an exact circle, and in height five hundred feet. This wall is a barranca, composed of lava, pumice, calcined lime, metamorphosed sandstone, vitrified rocks, and obsidien. This circumferent barranca is perforated through by the entrance and departure of the Rio del Norte, the Calebra, and the Costilla rivers, which traverse the northern, western and southern edges of the interior. By this and other forces of corrosion this barranca is on these three sides cut into isolated hills, called ceritos, of every fantastic form and of extraordinary beauty of shape and tints. The bottom of the crater has been filled up with the soils resulting from the decay of this variety of material, introduced by the currents of the water and of the atmosphere. It is beveled by these forces to a perfect level; is of the fattest fertility, and drained through the porous formation which underlies it.

From this crater to its southern rim, a distance of sixty-five miles, the park expands over a prodigious pedrigal formed from it in the period of volcanic activity. This pedrigal retains its level, and is perforated by the the Rio del Norte, whose longitudinal course is confined in a profound chasm or cañon, of perpendicular walls of lava, increasing to the depth of 1,200 feet, where it debouches from the jaws of this gigantic flood of lava, near the village of La Joya, in New Mexico. Such are the extraordinary forms and stupendous dimensions with which nature here salutes the eye and astonishes the imagination. The expansion of the lava is all to the south, following the descent toward the sea. Toward the north, repelled by the ascent, are waves demonstrating the defeated effort to climb the mountain base.

Such is an imperfect sketch of this wonderful amphitheater of the Sierras. Its physical structure is infinitely complex, exhibiting all the elements of nature piled in contact, yet set together in order and arranged in harmony; its cloud compelling Sierras, of stern primeval matter and proportions; its concave basin of fat fertility; its atmosphere of dazzling brilliancy, tonic temperature, and gorgeous tints; its arable and pastoral excellence, grand forests, and multitude of streams; its infinite variety of mines and minerals, embracing the whole catalogue of metals, rocks, clays and fuel; its capacity to produce grain, flax, wool, hides, vegetables, fruits, meats, poultry, and dairy food; the compact economy of arrangement which blends and interfuses all these varieties; these combine to provoke, stimulate, and reward the taste for physical and mental labor.

Entrance and exit over the rim of the park is everywhere made easy by convenient passes. Roads re-enter upon it from all points of the compass and every portion of the surrounding continent. These are not obstructed at any season. On the north is the Poncho pass, leading to the Upper Arkansas river, and into the south park. On the east, the Mosca and Sangre de Christo passes debouch immediately upon the great plains. On the south is the channel of the Rio del Norte. On the west easy roads diverge to the rivers Chamas, San Juan, and toward Arizona. In the northwest the Cocha-to-pee opens to the great Salt Lake and the Pacific. Convenient thoroughfares and excellent roads converge from all points and diverge with the same facility.

The system of the four parks, extending to the north, indefinitely amplifies and repeats all that characterizes the San Luis park. Smaller in size and less illustrated by variety, each one of the three by itself lingers behind the San Luis, but is an equal ornament in the same family. Their graceful forms, their happy harmony of contact and position, make their aggregated attractions the fascinating charm and glory of the American continent.

The abundance and variety of hot springs of every modulation of temperature is very great. These are also equalled by waters of medicinal virtues. It has been the paradise of the aboriginal stock, elsewhere so abundant and various. Fish, waterfowl, and birds of game and song and brilliant plumage frequent the streams and groves. Animal life is indefinite in quantity and abundantly various.

The atmospheric currents which sweep away every exhalation and all traces of malaria and miasma have an undeviating rotation. These currents are necessarily vertical in direction and equable in force, alternating smoothly as land and sea currents of the tropical islands of the ocean. The silence and serenity of the atmosphere are not ruffled; the changing temperature alone indicates the motion of nature.

All around the elliptical circumference of the plain, following as it were its shore, and bending with the indented base of the mountain, is an uninterrupted road of unparalleled excellence. This circuit is five hundred miles in length, and is graced with a landscape of uninterrupted grandeur, variety and beauty; on the one hand the mountains, on the other hand the concave plain, diversified with groves of alames and volcanic cerritos. At short intervals of five or ten miles asunder are crossed the swift-running current and fertile meadows of the converging mountain streams. Hot springs mingle their warm water with all these streams, which swarm with delicate fish and waterfowl.

The works of the beaver and otter are everywhere encountered, and water power for machinery is of singularly universal distribution. Agriculture classifies itself into pastoral and arable; the former subsisting on the perennial grasses, the latter upon irrigation everywhere attained by the streams and artificial acequias. This concave configuration and symmetry of structure is remarkably propitious in economy of labor and production, favored by the juxtaposition and variety of material, by the short and easy transport, and by the benignant atmosphere.

The supreme excellence of position, structure, and productions thus grouped within the system of the parks of Colorado, occupying the heart of the continental home of the American people, is conclusively discernable. Here is the focus of the mountains, of the great rivers and of the metals of the continent. The great rivers have here their extreme sources, which interlock and form innumerable and convenient passes from sea to sea. From these they descend smoothly to both oceans by continuous gradations. The parks occupy the line of the fortieth degree, and offer the facilities for a lodgement in force, at the highest altitude, where the highest divide of the continent exists, half way between the trough of the Mississippi and the Pacific shore. Being immediately approachable over the great plains their mines of precious metals are the nearest in the world to the social masses of the American people and to their great commercial cities. Their accessibility is perfect. All the elements of a perfect economy, food, health, geographical position, innumerable mines of the richest ores and every variety, erect, assist, and fortify one another.

The San Luis park has twenty-four thousand population. These people are of the Mexican-American race. Since the conquest of Cortez, A. D. 1520, the Mexican people have acquired and adopted the language, religion, and in modified forms the political and social systems of their European rulers. A taste for seclusion has always characterized the aboriginal masses, heightened by the geographical configuration of their peculiar territory. Upon the plateau elevated seven thousand feet above the oceans, and encased within an uninterrupted barrier of snow, reside nine millions of homogeneous people. An instinctive terror of the ocean, of the torrid heats and malarious atmosphere of the narrow coasts on either sea, perpetually haunts the natives of the plateau. To them navigation is unknown and marine life is abhorrent. The industrial energies of the people always active and elastic, and always recoiling from the sea, have expanded to the north, following the longitudinal direction of the plateau, of the mountains, and of the great rivers. This column of progress advances from south to north; it has reached and permanently occupies the southern half of the San Luis park.

At the same moment the column of the American people advancing in force across the middle belt of the continent, from east to west; is solidly lodged upon the eastern flank of the Cordillera, and is everywhere entering the parks through the passes. These two American populations, all of the Christian faith, here meet front to front, harmonize, intermarry, and reinvigorate the blended mass with the peculiar domestic accomplishments of each other.

The Mexican contributes his primitive skill, inherited for centuries without change, in the manipulations of pastoral and mining industry, and in the tillage of the soil by artificial irrigation. The American adds to these machinery and the intelligence of expansive progress. The grafted stock has the sap of both. As the coming continental railroad hastens to bind together our people isolated on the seas, a longitudinal railroad of 2,000 miles will unite with this in its middle course, bisecting the Territory, States and cities of 10,000,000 of affiliated people. This will fuse and harmonize the isolated peoples of our continent into one people, in all the relations of commerce, affinity and concord.

San Louis di Calebra, July 5, 1866.

ART. XXXVIII.—*Contributions to the Mineralogy of Nova Scotia;* by Prof. O. C. MARSH, of Yale College.—No. 1. *Ledererite identical with Gmelinite.*

DURING their first geological excursion to Nova Scotia, in 1827, Dr. C. T. Jackson, and the late Francis Alger, Esq., discovered a mineral at Cape Blomidon which has since been the subject of no little discussion among mineralogists.* These authors apparently regarded it from the first as a new species, but other authorities differed widely as to its true nature. Mr. Brooke of London, after measuring the angles of a crystal, pronounced it to be apatite, a view subsequently controverted by M. Dufrénoy of Paris, while Dr. Torrey of New York considered it nepheline.

Dr. Jackson subsequently described the mineral under the name *Ledererite*, in honor of Baron von Lederer, then Austrian Consul at New York;† and in the same paper Dr. A. A. Hayes, gave the results of an analysis he had made, on which its claims

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* Memoirs Am. Acad., vol. i. p. 253.
† This Journal, vol. xxv, p. 78.

to be considered a distinct species were mainly founded. The mineral examined had a specific gravity of 2·169, and its composition, according to this analysis, was as follows:—

Silica,	49·47
Alumina,	21·48
Lime,	11·48
Soda,	3·94
Phosphoric acid,	3·48
Oxyd of iron,	0·14
Foreign matter,	·03
Water,	8·58
	98·60

The large amount of phosphoric acid, and the small percentage of water obtained, although the determination of the latter was not entirely satisfactory, left the true character of this mineral still a matter of doubt. Berzelius attempted to clear up the difficulty by proposing a formula, based upon Dr. Hayes's analysis, according to which the mineral would consist of three atoms of lime-analcime and one of apatite.*

This view was adopted by Mr. Alger, who suggested also that the crystalline form of the analcime might have been changed to a hexagonal prism by the phosphate of lime.† Rammelsberg proposed to reject the phosphoric acid as an impurity, and with it an amount of lime sufficient to form tribasic phosphate of lime. This would leave a silicate differing from chabazite in having one-third the amount of water, and hence a lime-analcime.‡ The probable identity of Ledererite with Gmelinite appears to have been first suggested by the editors of the London and Edinburgh Philosophical Magazine in 1834;§ and Prof. Shepard, in his Mineralogy of 1835, and Prof. Dana, in his first edition in 1837, place it under that species. This view was subsequently accepted by both Mr. Alger and Dr. Jackson.‖ Finally Descloizeaux, in his Manuel (1862), published measurements of crystals by himself which sustain it.

Although the identity of Ledererite and Gmelinite was thus rendered highly probable, the chemical proof was still wanting, and it was very desirable to obtain more of the mineral for further investigation. At the request of Mr. Alger, the writer made a careful search for it at Cape Blomidon during several visits to Nova Scotia, but without success until the summer of 1861, when a number of crystals were found near the original locality, which had long been supposed to be exhausted. This was on the north coast of Cape Blomidon, at a point nearly op-

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* Jahresbericht, xiv, 175.

† Alger's Phillipp's Mineralogy, p. 630.

‡ Handwörterbuch, vol. i, p. 387.

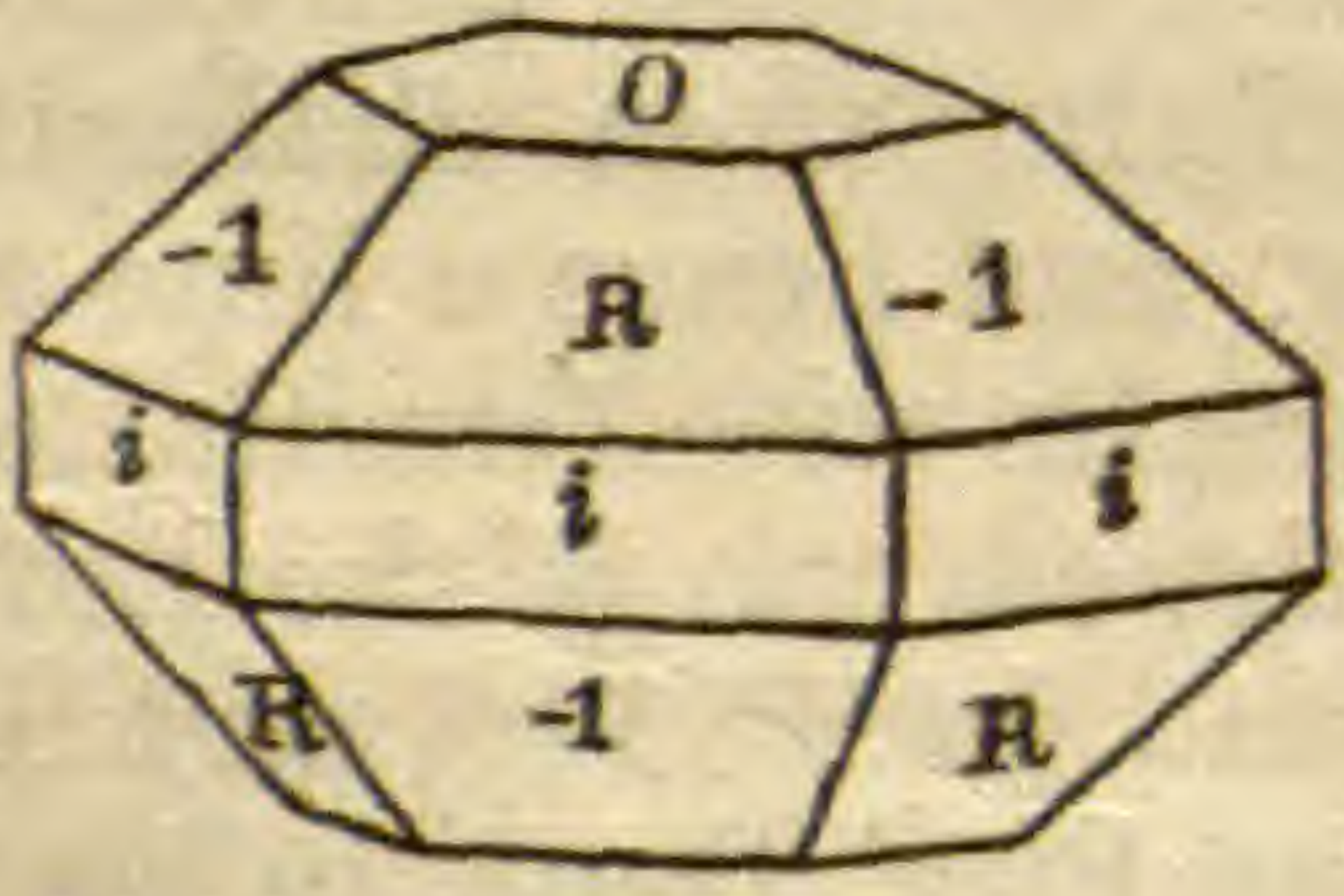
§ Vol. iv, p. 394.

‖ Boston Soc. Nat. Hist. Journal vol. v, p. 306.

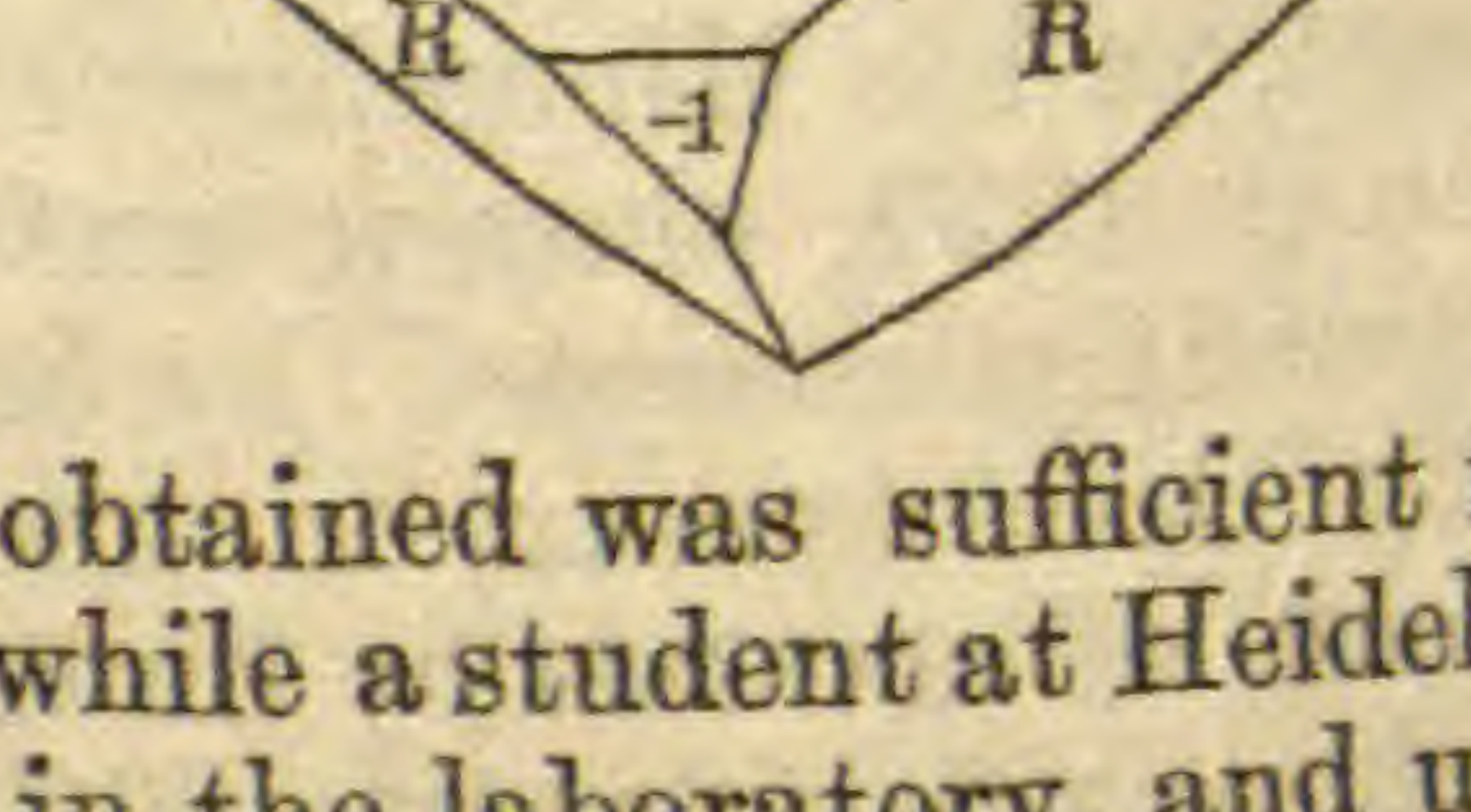
posite Cape Sharp. The crystals were found in geodes in the amygdaloid, accompanied by analcime and quartz, and in most instances implanted upon the latter substance. They were subsequently shown to Mr. Alger, who pronounced them identical with the Ledererite discovered by himself and Dr. Jackson.

The crystals were from one-tenth to one-third of an inch in diameter. Some of them, especially the smallest, were colorless, and nearly transparent; others were yellowish-white or faint salmon-red, and translucent. All were in the form of short hexagonal prisms with pyramidal terminations, as shown in the accompanying figures, that represented in fig. 1 being the typical form. In all the crystals observed the sides of the prisms were marked with horizontal striæ, while the planes of the pyramids were striated parallel to their polar edges. These striæ were in most instances much more distinct than those seen occasionally on crystals of Gmelinite from Irish localities, or from Iceland. There was, moreover, in most of the specimens a tendency toward a rhombohedral form, as seen in the much greater prominence of alternate pyramidal planes, a peculiarity rarely observed hitherto in Gmelinite. In several of the crystals this resulted in the form given in fig. 2.

1.



2.



As the amount of the mineral obtained was sufficient for a chemical examination, the writer, while a student at Heidelberg in 1863, made two analyses of it in the laboratory, and under the direction of Prof. Bunsen.

An attempt was first made to decompose the finely powdered mineral with hydrochloric acid, but without success, although continued over the water-bath for forty-eight hours. A second trial was made in the same way with sulphuric acid, but strange to say, the mineral was apparently little affected. In consequence of this unexpected difficulty, a portion of the mineral which remained was decomposed by hydrofluoric acid, according to Brunner's method, and the constituents, as given below in analysis No. 1*b*, separated in the usual manner. A third portion of the mineral was first used for a determination of the water, as given in No. 1*a*, and then fused with carbonate of soda, and its silica separated. A portion of the same mineral, but from a neighboring locality on Cape Blomidon, was also decomposed by fusion with carbonate of soda, and its composition, as given in analysis No. 2, determined in accordance with the usual methods. The amount employed in each analysis was one gram. The specific gravity of the mineral used in No. 1, was 2·108; in No. 2, 2·099, and the hardness in each case was about 4·5. The other physical, and the pyrognostic characters of the mineral, corresponded essentially with those observed in typical Gmelinite. The results obtained in the analyses were as follows:—

	1.		2.
	a	*b*	
Silica,	53·71	....	51·32
Alumina,		17·63	18·45
Lime,		6·52	6·40
Potash,		·80	by loss, 3·48
Soda,		3·10	
Phosphoric acid,		trace	....
Water,	17·98	....	20·35
		99·74	100.00

On comparing these results with those obtained by Dr. Hayes in his analysis, the only one previously made of Ledererite, it will be seen that they differ widely in respect to the amount of phosphoric acid and water—the two important points, in fact, which had occasioned discussion as to the nature of the mineral. It should perhaps, be added that in consequence of this discussion, special precautions were taken to guard against error in determining these substances. The small amount of material at command, rendered it impossible to repeat the analyses; but the results of those completed make clearly evident, what has long been suspected, that the phosphoric acid, found by Mr. Hayes, must be regarded as an impurity, and that Ledererite has essentially the same amount of water as Gmelinite, and hence is identical with that species. The evidence of this identity becomes still more apparent on comparing the composition of the Cape Blomidon mineral, deduced indirectly from a calculation of its constituents as given below, with the results obtained in analyses of typical Gmelinite.

The excess of silica obtained, especially in the first analysis, taken in connection with the remarkable difficulty of decomposition, naturally suggested the presence of impurities in the mineral; and, on examining with the microscope some fragments of a nearly colorless crystal, a quantity of minute crystals of quartz disseminated through the mass were detected. Several other crystals from the same locality were examined, and all found to contain quartz. This discovery clearly explained the large amount of silica obtained in analyzing the mineral, and also, perhaps, its resistance to decomposition.*

If, now, the results obtained in the above analyses be viewed in the light of this discovery, it is evident that the true composition of the mineral can only be ascertained from them by rejecting the quartz. Assuming, then, that the excess of silica in the substance analyzed was due to quartz,—of which, indeed, the microscopical examination afforded good evidence—and calculating from analysis No. 1, first the oxygen ratios respectively of the protoxyd bases, alumina, silica and water, they are found to be, 2·78 : 8·24 : 28·64 : 15·95, or very nearly 1 : 3 : $10\frac{1}{3}$: 6. As the oxygen of the bases should have to that of the silica the ratio of 1 : 2, all of the latter in excess must belong to the quartz. This would give 12·37 per cent for the amount of quartz in the mineral examined. Deducting this from the quantity of silica obtained, there remains but 41·34 of this substance for combination with the bases, and 87·37 for the sum of the constituents of the mineral itself. By calculating the percentage of these various constituents on the basis of the sum total of the first analysis, it becomes evident that the real composition of Ledererite, thus determined, is as follows :—

Silica,	47·19
Alumina,	20·13
Lime,	7·44
Potash,	·91
Soda,	3·54
Water,	20·53
	99·74

These results give the oxygen ratio of 1 : 3 : 8 : 6, and indicate for the mineral the formula $(\frac{1}{3}\dot{\mathrm{N}}\mathrm{a}+\frac{2}{3}\dot{\mathrm{C}}\mathrm{a})\dddot{\mathrm{S}}\mathrm{i}+\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}^3+6\dot{\bar{\mathrm{H}}}$, thus clearly establishing its identity with Gmelinite. In chemical consitution it differs from the normal Gmelinite only in having a considerable part of the soda replaced by lime, resembling in this respect the variety from Antrim, Ireland, analyzed by Connell.†

The fact that crystals of this Gmelinite from Cape Blomidon contained 12·37 per cent of silica as an impurity is a very important one, not merely in its bearing on the paragenesis of minerals, but especially for the explanation it suggests of many

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* Prof. Bunsen informed the writer that he once experienced a similar difficulty in analyzing a specimen of Chabazite, but made no special examination for impurities.

† Edin. Phil. Jour., xxiv, 362.

difficulties hitherto experienced in reconciling the results of analyses, particularly of silicates. On this point M. Lechartier of Paris has recently published some interesting facts, relating especially to the impurities detected in staurotide.*

New Haven, Oct. 10th, 1867.

ART. XXXIX.—*Notes on Fossils recently obtained from the Laurentian Rocks of Canada, and on objections to the organic nature of Eozoon;* by J. W. DAWSON, LL.D., F.R.S., F.G.S., *with Notes* by W. B. CARPENTER, M.D., F.R.S.

I. *Specimen of Eozoon from Tudor, C. W.*—This very interesting specimen, submitted to me for examination by Sir W. E. Logan, is, in my opinion, of great importance, as furnishing a conclusive answer to all those objections to the organic nature of *Eozoon* which have been founded on comparisons of its structures with the forms of fibrous, dendritic, or concretionary minerals, —objections which, however plausible in the case of highly crystalline rocks, in which organic remains may be simulated by merely mineral appearances readily confounded with them, are wholly inapplicable to the present specimen.

a. *General Appearance.*—The fossil is of a clavate form, six and a half inches in length, and about four inches broad. It is contained in a slab of dark-colored, coarse, laminated limestone, holding sand, scales of mica, and minute grains and fibers of carbonaceous matter. The surface of the slab shows a weathered section of the fossil; and the thickness remaining in the matrix is scarcely two lines, at least in the part exposed. The septa, or plates of the fossil, are in the state of white carbonate of lime, which shows their form and arrangement very distinctly, in contrast to the dark stone filling the chambers. The specimen lies flat in the plane of stratification, and has probably suffered some compression. Its septa are convex toward the broad end, and somewhat undulating. In some places they are continuous halfway across the specimen; in other places they divide and reunite at short distances. A few transverse plates, or connecting columns, are visible; and there are also a number of small veins or cracks passing nearly at right angles to the septa, and filled with carbonate of lime, similar in general appearance to the septa themselves.

On one side, the outline of the fossil is well preserved. The narrow end, which I regard as the basal portion, is rounded. The outline of the side first bends inward, and then outward, forming a graceful double curve, which extends along the greater

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* Bulletin de la Soc. Chimique, May, 1865, p. 375.

part of the length. Above this is an abrupt projection, and then a sudden narrowing; and in the middle of the narrow portion, a part has the chambers obliterated by a white patch of carbonate of lime, below which some of the septa are bent downward in the middle. This is probably an effect of mechanical injury, or of the interference of a calc-spar vein.

With the exception of the upper part above referred to, the septa are seen to curve downward rapidly toward the margin, and to coalesce into a lateral wall, which forms the defined edge or limit of the fossil, and in which there are some indications of lateral orifices opening into the chambers. It is worthy of remark that, in this respect, the present specimen corresponds exactly with that which was originally figured by Sir W. Logan in the 'Geology of Canada,' p. 49, and which is the only other specimen that exhibited the lateral limit of the form.

On the side next the matrix, the septa terminate in blunt edges, and do not coalesce; as if the organism had been attached by that surface, or had been broken before being imbedded.

b. *Microscopic Characters.*—Under the microscope, with a low power, the margins of the septa appear uneven, as if eroded or tending to an acervuline mode of growth; but occasionally the septa show a distinct and regular margin. For the most part merely traces of structure are presented, consisting of small parts of canals, filled with the dark coloring-matter of the limestone. In a few places, however, these appear as distinct bundles, similar to those in the Grenville specimens, but of fine texture.

In a few rare instances only, can I detect, with a higher power, in the margin of some of the septa, traces of the fine tubulation characteristic of the proper chamber-wall of *Eozoon.* For the most part this seems to have been obliterated by the infiltration of the tubuli with colorless carbonate of lime, similar to that of the skeleton.

In comparing the structure of this specimen with that of those found elsewhere, it would appear that the chambers are more continuous, and wider in proportion to the thickness of the septa, and that the canal-system is more delicate and indistinct than usual. In the two former respects the specimens from the Calumet and from Burgess approach that now under consideration more nearly than do those from Grenville and Petite Nation; but it would be easy, even in the latter, to find occasional instances of a proportion of parts similar to that in the present example. General form is of little value as a character in such organisms; and, so far as can be ascertained, this may have been the same in the present specimen and in that originally obtained from the Calumet, while in the specimens from Grenville a massive and aggregative mode of growth seems to have obliterated all distinctness of individual shape. Without additional specimens, and in the case of creatures so variable as the Foraminifera, it would be rash to decide whether the differences above noticed are of specific value, or depend on age, variability, or state of preservation. For this reason I refer the specimen for the present to *Eozoon Canadense*, merely distinguishing it as the Tudor variety.

From the state of preservation of the fossil, there are no crystalline structures present which can mislead any ordinarily skilful microscopist, except the minute veins of calcareous spar traversing the septa, and the cleavage-planes which have been developed in some portions of the latter.

I would remark that, as it seemed desirable not to injure any more than was absolutely necessary a unique and very valuable specimen, my observations of the microscopic structure have been made on a few slices of small size,—and that, as the microscopic structures are nearly the same in kind with those of specimens figured in former papers, I have not thought it necessary to prepare numerous drawings of them; while the admirable photograph executed for Sir W. E. Logan by Mr. Norman illustrates sufficiently the general form and arrangement of parts.

c. *Concluding Remarks.*—In a letter to Dr. Carpenter, quoted by him in the 'Quarterly Journal of the Geological Society' for August, 1866, p. 228, I referred to the occurrence of *Eozoon* preserved simply in carbonate of lime. The specimens which enabled me to make that statement were obtained at Madoc, near Tudor, this region being one in which the Laurentian rocks of Canada appear to be less highly metamorphosed than is usual. The specimens from Madoc, however, were mere fragments, imbedded in the limestone, and incapable of showing the general form. I may explain, in reference to this, that long practice in the examination of these limestones has enabled me to detect the smallest *Eozoon* when present, and that in this way I had ascertained the existence of this fossil in one of the limestones of Madoc before the discovery of the fine specimen now under consideration.

I am disposed to regard the present specimen as a young individual, broken from its attachment and imbedded in a sandy calcareous mud. Its discovery affords the hope that the comparatively unaltered sediments in which it has been preserved, and which also contain the worm-burrows described by me in the 'Quarterly Journal of the Geological Society' for November,* will hereafter still more largely illustrate the Laurentian fauna.

II. *Specimens from Long Lake and Wentworth.*—Specimens from Long Lake, in the collection of the Geological Survey of Canada, exhibit white crystalline limestone with light-green compact or septariiform† serpentine, and much resemble some of

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* Vol. xxii, p. 608.

† I use the term "septariiform" to denote the *curved* appearance so often presented by the Laurentian serpentine.

the serpentine limestones of Grenville. Under the microscope the calcareous matter presents a delicate areolated appearance, without lamination; but it is not an example of acervuline *Eozoon*, but rather of fragments of such a structure, confusedly aggregated together, and having the interstices and cell-cavities filled with serpentine. I have not found in any of these fragments a canal-system similar to that of *Eozoon Canadense*, though there are casts of large stolons, and, under a high power, the calcareous matter shows in many places the peculiar granular or cellular appearance which is one of the characters of the supplemental skeleton of that species. In a few places a tubulated cell wall is preserved, with structure similar to that of *Eozoon Canadense.*

Specimens of Laurentian limestone from Wentworth, in the collection of the Geological Survey, exhibit many rounded siliceous bodies, some of which are apparently grains of sand, or small pebbles; but others, especially when freed from the calcareous matter by a dilute acid, appear as rounded bodies, with rough surfaces, either separate or aggregated in lines or groups, and having minute vermicular processes projecting from their surfaces. At first sight these suggest the idea of spicules; but I think it on the whole more likely that they are casts of cavities and tubes belonging to some calcareous Foraminiferal organism which has disappeared. Similar bodies, found in the limestone of Bavaria, have been described by Gümbel, who interprets them in the same way.* They may also be compared with the siliceous bodies mentioned in a former paper as occurring in the Loganite filling the chambers of specimens of *Eozoon* from Burgess.

III. *Specimens from Madoc.*—I have already referred to fragments of *Eozoon* occurring in the limestone at Madoc, one of which, found several years ago, I did not then venture to describe as a fossil. It projected from the surface of the limestone, being composed of a yellowish dolomite, and looking like a fragment of a thick shell. When sliced, it presents interiorly a crystalline dolomite, limited and separated from the enclosing rock by a thin wall having a granular or porous structure and excavated into rounded recesses in the manner of *Eozoon*. It lies obliquely to the bedding, and evidently represents a hollow flattened calcareous wall filled by infiltration. The limestone which afforded this form was near the beds holding the apparently worm-burrows described in the Society's Journal for November, 1866.

[A thin section of this body, carefully examined microscopically, presents numerous and very characteristic examples of the canal-system of *Eozoon*, exhibiting both the large widely branch-

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* Proceedings of Royal Academy of Munich, 1866; Q. J. G. S., vol. xxii, pt. i, p. 185 et seq.

ing systems of canals and the smaller and more penicillate tufts shown in the most perfect of the serpentinous specimens—but with this difference, that the canals, being filled with a material either identical with or very similar to that of the substance in which they are excavated, are so transparent as only to be brought into view by careful management of the light.—W. B. C.]

IV. *Objections to the Organic Nature of Eozoon.*—The discovery of the specimen from Tudor, above described, may appear to render unnecessary any reference to the elaborate attempt made by Profs. King and Rowney to explain the structures of *Eozoon* by a comparison with the forms of fibrous and dendritic minerals,* more especially as Dr. Carpenter has already shown their inaccuracy in many important points. I think, however, that it may serve a useful purpose shortly to point out the more essential respects in which this comparison fails with regard to the Canadian specimens—with the view of relieving the discussion from matters irrelevant to it, and of fixing more exactly the limits of crystalline and organic forms in the serpentine limestones and similar rocks.

The fundamental error of Messrs. King and Rowney arises from defective observation—in failing to distinguish, in the Canadian limestones themselves, between organic and crystalline forms. This is naturally followed by the identification of all these forms, whether mineral or organic, with a variety of purely crystalline arrangements occurring in other rocks, leading to their attaching the term "Eozoonal" to any rock which shows any of the characters, whether mineral or organic, thus arbitrarily attached to the Canadian *Eozoon*. This is obviously a process by which the structure of any fossil might be proved to be a mere *lusus naturæ.*

A notable illustration of this is afforded by their regarding the veins of fibrous serpentine, or chrysotile, which occur in the Canadian specimens, as identical with the tubulated cell-wall of *Eozoon*—although they admit that these veins traverse all the structures indifferently and do not conform to the walls of the chambers. But any microscopist who possesses specimens of *Eozoon* containing these chrysotile veins may readily satisfy himself that, under a high power, they resolve themselves into *prismatic crystals in immediate contact with each other;* whereas, under a similar power, the true cell-wall is seen to consist of *slender, undulating, rounded threads of serpentine, penetrating a matrix of carbonate of lime.* Under polarized light more especially, the difference is conspicuously apparent. It is true that, in many specimens and parts of specimens, the cell-wall of *Eozoon* is badly preserved and fails to show its structure; but in no instance does it present the appearance of chrysotile, or of any

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* Quart. Journ. Geol. Soc., vol. xxii, pt. ii, p. 23.

other fibrous mineral, when examined with care under sufficiently high powers. In my original examination of Sir William Logan's specimens from Grenville and the Calumet, I did not detect the finely tubulated cell-wall, which is very imperfectly preserved in those specimens; but the veins of fibrous serpentine were well known to me; and when Dr. Carpenter discovered the tubulation of the cell-wall in the specimens from Petite Nation, I compared this structure with that of these veins, and satisfied myself of its distinctness before acceding to his conclusions on this point.

It would also appear that the radiating and sheaf-like bundles of crystals of tremolite, or similar prismatic minerals, which occur in the Canadian serpentines, and also abound in those of Connemara, have been found with the tubulation of *Eozoon*; but these crystals have no definite relation to the forms of that fossil, and often occur where these are entirely absent; and in any case they are distinguishable by their straight prismatic shape and their angular divergence from each other. Much use has also been made of the amorphous masses of opaque serpentinous matter which appear in some parts of the structure of *Eozoon*. These I regard as, in most cases, simply results of alteration or defective preservation, though they might also arise from the presence of foreign matters in the chambers, or from an incrustation of mineral matter before the final filling up of the cells. Generally their forms are purely inorganic; but in some cases they retain indications of the structures of *Eozoon*.

With reference to the canal-system of *Eozoon*, no value can be attached to loose comparisons of a structure so definite with the forms of dendritic silver and the filaments of moss-agates; still less can any resemblance be established between the canal-system and vermicular crystals of mica. These occur abundantly in some serpentines from the Calumet, and might readily be mistaken for organic forms; but their rhombic or hexagonal outline when seen in cross section, their transverse cleavage-planes, and their want of any definite arrangement or relation to any general organic form are sufficient to undeceive any practised observer. I have not seen specimens of the metaxite from Reichenstein referred to by Messrs. King and Rowney; but it is evident, from the description and figure given of it, that, whether organic or otherwise, it is not similar to the canals of *Eozoon Canadense*. But all these and similar comparisons are evidently worthless when it is considered that they have to account for definite, ramifying, cylindrical forms, penetrating a skeleton or matrix of limestone, which has itself a definite arrangement and structure, and, further, when we find that these forms are represented by substances so diverse as serpentine, pyroxene, limestone, and carbonaceous matter. This is intelligible on the supposition of tubes filled with foreign matters, but not on that of dendritic crystallization.

If all specimens of *Eozoon* were of the acervuline character, the comparisons of the chamber-casts with concretionary granules might have some plausibility. But it is to be observed that the laminated arrangement is the typical one; and the study of the larger specimens, cut under the direction of Sir W. E. Logan, shows that these laminated forms must have grown on certain strata-planes before the deposition of the overlying beds, and that the beds are, in part, composed of the broken fragments of similar laminated structures. Further, much of the apparently acervuline *Eozoon* rock is composed of such broken fragments, the interstices between which should not be confounded with the chambers; while the fact that the serpentine fills such interstices as well as the chambers shows that its arrangement is not concretionary.* Again, these chambers are filled in different specimens with serpentine, pyroxene, loganite, calcareous spar, chondrodite, or even with arenaceous limestone. It is also to be observed that the examination of a number of limestones, other than Canadian, by Messrs. King and Rowney, has obliged them to admit that the laminated forms in combination with the canal-system are "essentially Canadian," and that the only instances of structures clearly resembling the Canadian specimens are afforded by limestones Laurentian in age and in some of which (as, for instance, in those of Bavaria and Scandinavia) Carpenter and Gümbel have actually found the structure of *Eozoon.* The other serpentine-limestones examined (for example, that of Skye) are admitted to fail in essential points of structure; and the only serpentine believed to be of eruptive origin examined by them is confessedly destitute of all semblance of *Eozoon.* Similar results have been attained by the more careful researches of Prof. Gümbel, whose paper is well deserving of study by all who have any doubts on this subject.

In the above remarks I have not referred to the disputed case of the common limestones; but I may state that I have not been able to satisfy myself of the occurence of the structures of *Eozoon* in such specimens as I have had the opportunity to examine.† It is perhaps necessary to add that there exists in Canada abundance of Laurentian limestone which shows no indication of the structures of *Eozoon.* In some cases it is evident that such structures have not been present. In other cases they may have been obliterated by processes of crystallization. As in the case of other fossils, it is only in certain beds,

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* I do not include here the "septariiform" structure referred to above, which is common in the Canadian serpentine and has no connection with the forms of the chambers.

† Such Irish specimens of serpentine limestone as I have seen, appear much more highly crystalline than the beds in Canada which contain *Eozoon.*

and in certain parts of those beds, that well-characterized specimens can be found. I may also repeat here that in the original examination of *Eozoon*, in the spring of 1864, I was furnished by Sir W. E. Logan with specimens of all these limestones, and also with serpentine-limestones of Silurian age, and that, while all possible care was taken to compare these with the specimens of *Eozoon*, it was not thought necessary to publish notices of the crystalline and concretionary forms observed, many of which were very curious and might afford materials for other papers of the nature of that criticised in the above remarks.

[The examination of a large number of sections of a specimen of *Eozoon* recently placed in my hands by Sir William Logan, in which the canal system is extraordinarily well preserved, enables me to supply a most unexpected confirmation of Dr. Dawson's statements in regard to the occurrence of dendritic and other forms of this system, which cannot be accounted for by the intrusion of any foreign mineral; for many parts of the calcareous lamellæ in these sections, which, when viewed by ordinary transmitted light, appear quite homogeneous and structureless, are found, when the light is reduced by Collin's "graduating diaphragm," to exhibit a most beautiful development of various forms of canal-system (often resembling those of Dr. Dawson's Madoc specimen, which cross the cleavage-planes of the shell-substance in every direction. Now these parts, when subjected to decalcification, show no trace of canal-system; so that it is obvious, both from their optical and from their chemical reactions, that the substance filling the canals must have been *carbonate of lime*, which has thus completely solidified the shell layer, having been deposited in the canals previously excavated in its interior, just as crystalline carbonate of lime fills up the reticular spaces of the skeleton of Echinodermata fossilized in a calcareous matrix. This fact affords conclusive evidence of *organic structure*, since no conceivable process of crystallization could give origin to dendritic extensions of carbonate of lime disposed on exactly the same crystalline system with the calcite which includes it, the two substances being mineralogically homogeneous, and only structurally distinguishable by the effect of their junction-surfaces on the course of faint rays of light transmitted through them.—W. B. C.]

[The preceding paper was drawn out in part by the observation of Messes. King and Rowney on the Eozoon published in the Quarterly Journal of the Geological Society, vol. xxii, pages 185 to 217, and illustrated by two plates. The following are the *Summary* and *Conclusion* with which the paper of Messrs. King and Rowney closes.—EDS.]

X. *Summary.*—Although zealous advocates at one time for the organic origin of "eozoonal" Ophite, we now, after a prolonged investigation, and after, as we believe, leaving no point unnoticed, feel ourselves under the necessity of totally relinquishing that opinion.

It has been seen (1) that the "chamber-casts" or granules of serpentine are more or less simulated by chondrodite, coccolite, pargasite, &c., also by the bytryoidal configurations common in Permian Magnesian Limestone; (2) that the "intermediate skeleton" is closely represented, both in chemical composition and other conditions, by the matrix of the above and other minerals; (3) that the "proper wall" is structurally identical with the asbestiform layer which frequently invests the grains of chondrodite—that, instead of belonging to the skeleton, as must be the case on the eozoonal view, it is altogether independent of that part, and forms on the contrary, an integral portion of the serpentine constituting the "chamber-casts," under the allomorphic form of chrysotile—and that perfectly genuine specimens of it, completely simulating *casts* of separated nummuline tubules, occur in true fissures of the serpentine granules; (4) that the "canal-system" is analogous to the imbedded crystallizations of native silver and other similarly conditioned minerals, also to the coralloids imbedded in Permian Magnesian Limestone—that its typical Grenville form occurs as metaxite, a chemically identical mineral imbedded in saccharoidal calcite; (5) that the type examples of "casts of stolen-passages" are isolated crystals apparently of pyrosclerite. Furthermore, considering that there has been a complete failure to explain the characters of the so-called internal casts of the "pseudopodial tubules" and other "passages" on the hypothesis of ordinary mechanical or chemical infiltration, also bearing in mind the significant fact that the "intermediate skeleton," in Irish and other varieties of "eozoonal rocks," contains modified examples of the "definite shapes" more or less resembling the crystalline aggregations and prismatic lumps in primary saccharoidal marbles—that "eozoonal" structure is only found in metamorphic rocks belonging to widely separated geological systems, never in their unaltered sedimentary deposits,—taking all these points into consideration, also the arguments and other evidences contained in the present memoir, we feel the conclusion to be fully established, that every one of the specialities which have been diagnosed for "*Eozoon Canadense*" is solely and purely of crystalline origin: in short, we hold, without the least reservation, that, from every available standing point—foraminiferal, mineralogical, chemical, and geological—the opposite view has been shown to be utterly untenable.

XI. *Conclusion.*—From what has been stated in some of the preceding pages, respecting the various chemical changes which "eozoonal" Ophite appears to have undergone, and its mineralogical constituents, we are strongly inclined to believe that it is a pseudomorphic rock, that it existed at one time in the ordinary metamorphic state, perhaps as hornblendic or augitic gneiss, and that it is primarily of sedimentary origin. Whether the same may be concluded of all ophitic rocks is a question on which we cannot offer any opinion—negative, or affirmative. There are some grounds for believing, however, that certain dolerites, generally considered to be of eruptive origin, have become changed into Ophite: and though we have not detected any "eozoonal" structure in an example apparently of the kind, from Monzoni in the Tyrol, which has fallen under our observation, it would not surprise us if this structure were found in ophitic rocks supposed to belong to the eruptive section, considering that the essential mineral (augite) of dolerite contains a large percentage of silicate of lime.

ART. XL.—*Reply to Mr. Gabb on the Cretaceous rocks of California;* by T. A. CONRAD.

IN the last number of this Journal, Mr. Gabb in some remarks on the age of certain fossils of California, charges me with an "unfair avoidance of a difficulty." I am not aware of either a difficulty or unfairness. The latter refers to the omission of several of his species in my Eocene Check List. This I did for the sufficient reason that I could not be sure whether his typical form was from division A or B of his Cretaceous rocks. I believe that he has in only one instance figured a supposed identical species from each division, and in that instance the shells are not specifically, nor I think even generically related. After such experience, it could hardly be expected that I should trust his judgment in other comparisons.

Mr. Gabb includes the genus *Anchura* Conrad, in division B, but from his statement in his Paleontology it appears not to have been found associated with other fossils, and therefore it is much more likely to be a genus of division A, inasmuch as it has never been found in the Tertiary of any region. He says that the genera *Gyrodes*, *Perrisolax* and *Margaritella* are strictly Cretaceous, which I admit, but his species of *Perrisolax* in division B, is a member of an Eocene genus *Levifusus*, and which is closely related to a Claiborne species. He makes no mention of *Gyrodes* in division B, in his Paleontology, and of *Margaritella* he refers *M. globosa* to division A, and makes no mention of its occurrence in division B, and *M. crenulata* he refers to no particular division.

It can hardly be reasonable to complain of my omission of *Callianassa* in a Check List devoted exclusively to Testacea, and I doubt the identification of such imperfect specimens of crab's hands as he has figured.

I omitted Ammonites n. s. because it was neither figured nor described, and might be an accidental intruder among Eocene fossils, as so many Cretaceous shells have been found to be. Would it be fair to place the Miocene beds of Cape Fear river, N. C., in the Cretaceous formation on account of the presence of two Cretaceous fossils, *Exogyra costata* and *Cucullæa vulgaris ?*

Mr. Gabb compares his division B to the Maestricht beds, but the latter contain Belemnites, Ammonites, Baculites and Hamites, and according to Lyell, no Tertiary species; whereas Mr. Gabb includes in his division B, the Tertiary genera *Aturia, Venericardia, Dosinia, Pseudoliva* and *Ficus.* His *Dosinia elevata,* however, is a species of a very different Eocene genus, *Dosiniopsis* Conrad. *D. pertenuis* Gabb is either another species of *Dosiniopsis* or a younger specimen of *elevata. D. gyrata* is not stated to occur in division A, and *D. inflata* can hardly be a *Dosinia.* Any evidence so far is wanting to prove the strata in question Cretaceous, and as the group of fossils is so decidedly Tertiary in their forms and some species identical, I am forced to the conclusion of their Eocene origin.

ART. XLI.—*Geographical Notices.*

I. NOTE ON THE DIVERSITIES IN PUBLISHED ESTIMATES OF THE HEIGHT OF MOUNT WASHINGTON, NEW HAMPSHIRE.

THE variation, in statements pretending to approach accuracy, concerning the height of Mt. Washington, has been before remarked, but it may be interesting to see, in numerical order, the principal computations, and estimates given, in English feet, above the level of the sea. They are as follows:—

1. 6,103, as quoted by Prof. Jacob Bigelow in an article presently to be mentioned, from the observations of Capt. Alden Partridge, of Norwich, Vt.

2. 6,128, given on the maps of Colton's General Atlas, edition of 1866; though in the text of the same work the height given is 6,496 feet, we are not told on what authority.

3. 6,225, from barometric observations, made in July, 1816, by a botanical party, comprising Prof. Jacob Bigelow, M. D., of

Harvard College, Dr. Francis Boott, late of London, and Lemuel Shaw, late Chief Justice of Supreme Court of Mass., then all young men. The observations were reduced by Prof. Farrar, of Harvard College. An account by Dr. Bigelow of this visit, is in the New England Journal of Medicine and Surgery, Oct. 1816.

4. 6,226, (or by a series of observations, 6,228,) the height determined by Dr. Chas. T. Jackson, State Geologist, and Messrs. J. D. Whitney, M. B. Williams and Eben Baker, assistants, by barometric and thermometric observations, for a period of 12 hours. See "First Report on Geol. of New Hampshire," 1841, p. 102.

5. 6,238, from barometric observations of Capt. Partridge, in 1821, still retained by some of the Common School Atlases.

6. 6,285, obtained by Prof. Bond, of Cambridge Observatory, with barometer and theodolite. The same result obtained by N. A. Goodwin, C. E., by spirit level. This measurement was adopted by Appleton's New Amer. Cyclopædia, N. Y., 1863.

7. 6,280, from the levelling of Capt. T. J. Cram, Top. Eng., Assist. U. S. Coast Survey, published in Coast Survey Report for 1854. Simultaneous observations, by the barometer, gave 6,206, and by thermo-barometer, boiling point, 6,116.

8. 6,288, Prof. Guyot's final measurement, by barometer, of which a full account is given in this Journal, II, xxxi, 156, March, 1861.

9. 6,290, was a former result obtained by the same, Aug., 1851.

10. 6,293, U. S. Coast Survey, in 1853, (so stated by Prof. Guyot.)

11. 6,428, the result of seven days' observations with a spirit level, Aug. 1820, conducted by Messrs. A. N. Brockett and J. W. Weeks, of Lancaster, N. H., and described in Farmer & Moore's "N. H. Hist. Collections," Apl., 1823, (ii, 97). This measurement is followed in Lippincott's Gazetteer of U. S., Johnston's Physical Atlas, Edinburgh, 1856, the Imperial Gazetteer, Glasgow, 1855, &c.

12. 6,652 is Humboldt's statement (Views of Nature), purporting to follow Lyell. Lyell's "Second Visit to U. S." (1845) gives, however, Dr. Bigelow's measurement.

13. 6,817 (2,078 meters), according to Guibert's Dict. Géographique et Statistique, Paris, 1855.

14. 7,000 and over, McCulloch's Geogr. Dict., edition of 1849.

15. 7,055, and 7,162. In July, 1804, Rev. Manasseh Cutler, LL.D., of Ipswich, Mass., with Dr. W. D. Peck, afterward Prof. of Nat. Hist. at Cambridge, made several barometric observations, which, reduced by Dr. Bowditch (in Mem. Amer. Acad. Arts and Sci., for 1815, vol. iii, pt. 2, p. 326), gave these results.

16. 7,800. Rev. Samuel Williams, LL.D., previously Prof. of Mathematics in Harvard College, in his Hist. of Vermont, published 1794, calculated from the existence of snow on these mountains from Oct. to July, that they nearly reach the line of perpetual congelation, or 7,872 feet. He calls their altitude hardly more than 7,800.

17. 8,000. "The White Mountains are estimated to be at least 8,000 feet high," according to Elements of Useful Knowledge, by Noah Webster, 1812.

18. 9,800, obtained by the first scientific exploring party on record, in July, 1784, from imperfect barometric observations. Of the party were Dr. Cutler, of Ipswich, Rev. D. Little, of Kennebunk, Col. John Whipple, and Rev. Dr. Belknap. The last furnished an account of the trip to the Amer. Philosophical Society, published 1786, in their Transactions (ii, 42).

19. 10,000 and over. Dr. Belknap, however, in his Hist. of New Hampshire, vol. 3, published 1792, expresses himself "persuaded, that whenever the mountain can be measured with the requisite precision, it will be found to *exceed* 10,000 feet, of perpendicular altitude, above the level of the ocean." He adds, that "this peak has lately been distinguished by the name of Mt. Washington." Mr. E. A. Kendall, an Englishman who traveled through Northern U. S. in 1808, records the same as the usual estimate.

20. 11,000 and over, was the height sanctioned by Morse's series of Geographies, at least as late as 1819.

21. 12,729, according to Pres. Dwight's Travels, 1803 (ii, 163.) "It is proverbially asserted," he says, "along the eastern coast, that Mt. Washington is distinctly visible 30 leagues from the shore." He then estimates the distance as at least 140 miles, and adds: "The elevation of this summit, calculating upon its visibility at this distance, and making the proper allowance for the refraction of light, will be 12,729 feet. Another deduction ought, however, to be made for the fact, that, instead of being seen at the surface, it probably is always first perceived at mast head."

22. Above the lower limit of perpetual snow!—so given in a primary geography published in 1859, at New Haven. "The White Mountains have this name because their tops are covered with snow and ice *all the summer*, as well as in the winter."

II. NOTES ON RECENT GEOGRAPHICAL MAPS, BOOKS AND INTELLIGENCE.

Russian America.—The recent purchase of this important province by our government, has awakened special attention to its physical characteristics. We have already announced the departure from San Francisco of a scientific party, who are to engage in the exploration of that comparatively unknown region.

By far the best summary, in English, of what is now known respecting Russian America, may be found in the speech of Hon. Charles Sumner, Chairman of the Committee on Foreign Affairs, delivered in the U. S. Senate, when the treaty of cession was presented to that body (Wash. 1867, 8vo, pp. 48). Appended to the pamphlet is a map, which exhibits not merely the newly acquired Alaska, but also its relations to the East coast of Asia, and the great Behrings sea. This map, which is on the scale of 1: 5,000,000, was prepared at the office of the U. S. Coast Survey, and is separately published.

Senator Sumner, with the varied learning for which he is distinguished, recapitulates the sources of information in European literature respecting Alaska, and then proceeds to make up from them all a monograph of the country, considered under these seven heads; first, government; second, population; third, climate; fourth, vegetation; fifth, minerals; sixth, furs; seventh, fisheries. Our limits only allow us, in this brief way, to call attention to this survey. In respect to the climate, we transcribe a striking tabular statement, compiled at the request of Mr. Sumner, from the archives of the Smithsonian Institution, by one of the collaborators who visited Russian America under the auspices of the telegraph company.

	Mean Temperature in degrees Fahrenheit.					Precipitation in Rain or Snow. Depth in inches.				
	Spring.	Summer.	Autumn.	Winter.	Year.	Spring.	Summer.	Autumn.	Winter.	Year.
St. Michales, Russian Amer. Lat. 63° 28′ 45″ North.	28.75	52.25	27.00	7.00	27.48					
Fort Youkon, Russian Am. Lat. (near) 67°.	14.22	59.67	17.37	23.80	16.92					
Ikogmut, Russian America. Lat. 61° 47′.	19.62	49.32	36.05	0.95	24.57					
Sitka, Russian America. Lat. 57° 03′.	39.65	53.37	43.80	32.30	42.12	18.32	15.75	32.10	23.77	89.94
Puget sound, Wash. Ter. Lat. 47° 07′.	48.88	63.44	51.30	39.38	50.75	7.52	3.68	15.13	20.65	46.98
Astoria, Oregon. Lat. 40° 11′.	51.16	61.36	53.55	42.43	52.13	16.43	4.85	21.77	44.15	87.20
San Francisco, California. Lat. 37° 48′.	55.39	58.98	58.29	50.25	55.73	6.65	0.09	2.69	13.49	22.92
Nain, Labrador. Lat. 57° 10′.	23.67	48.57	33.65	0.40	26.40					
Montreal, Canada East. Lat. 45° 30′.	41.20	68.53	44.93	16.40	42.77	7.66	11.20	7.42	.72	27.00
Portland, Maine. Lat. 43° 39′	40.12	63.75	45.75	21.52	42.78					
Fort Hamilton, New York. Lat 40° 37′.	47.84	71.35	55.79	32.32	51.82	11.69	11.64	9.88	10.31	43.22
Washington, Dist. of Col.	54.19	73.07	53.91	33.57	53.69	10.48	10.53	10.16	10.06	41.24

It will be seen, from this table, that the winters of Sitka are relatively warm, not differing much from those of Washington, and several degrees warmer than those of New York; but the summers are colder. The mean temperature of winter is 32° 30′, while that of summer is 53° 37′. The Washington winter is 38° 57′; the Washington summer is 73° 07′. These points exhibit the peculiarities of this Alaskan coast—warm winters and cool summers.

Inter-oceanic Canals and Railroads, between the Atlantic and Pacific Oceans.—Rear Admiral C. H. Davis, as Superintendent of the National Observatory, prepared last year for the Secretary of the Navy, in pursuance of a resolution of the U. S. Senate, a Report on the means of inter-oceanic communication across the great American Isthmus (Wash. 1867, 8vo., 38 pp. 14 maps). The Report contains a series of important maps and profiles, and among them (in the second edition, March 14, 1867) may be found a very curious copy of a Spanish map of Darien, based on surveys made between 1780 and 1790. All the twenty-six transit projects, including railroads and canals, which have been offered to the world, are briefly characterized by Admiral Davis, important statistical tables are appended, and a bibliographical list of the authorities on the subject is also given. The maps and profiles embody the most important results acquired in the various surveys of Barnard, Squier, Hughes, Trautwine, McDougal, Michler, and others.

Two maps of what is known as the "*North Western Boundary*" between the United States and Great Britain, have just been printed by the Government at Washington. They are compiled under the direction of Archibald Campbell, Commissioner, and John G. Parke, U. S. Eng., Chief Astronomer and Surveyor of the N. W. Boundary Survey.

The country delineated, is that lying between the 110th meridian, the sea coast, and between the parallels of 46° and 49° 30′, N. lat. Thus the basins of the Columbia and Fraser rivers, and Vancouver's Island, etc., are included. The effort has been made to present not merely the original work of the survey, but also the investigations of other British and American explorers. The topography is quite in detail, but is not always satisfactory, especially in the representation of mountains. For example, the marked predominance of Mt. St. Helens, and Mt. Adams, above the adjacent country, would not be inferred from the map. The publication of the accompanying Report of the Commission, is deferred as we learn by a letter of the Commissioner, until the meeting of Congress.

Copies of the *Journal of the Royal Geographical Society of London*, vol. xxxvi, for 1866, have just been received. It contains more than the usual variety of interesting papers and maps. Among them, we may mention an account, by M. Chandless, of his ascent of the River Purûs, one of the chief tributaries of the Amazon, in 1864 and 1865. He has drawn a map of the river, from his own astronomical observations and measurements. The astronomical data are said to be the first ever ascertained, notwithstanding that there have been four previous surveys of the river. Mr. Chandless also contributes a paper on the river Aquiry, the principal affluent of the river Purûs. For these unaided surveys over a distance of 1,866 miles, the Geographical Society awarded to Mr. Chandless the Victoria gold medal. Two articles, translated from the Russian of M. Veniukof, convey a large amount of interesting matter, respecting the knotty and hitherto unsatisfactory geography of the Bolor Dagh, and the country of the Belors.

Five numbers have reached us of a new "*Dictionnaire de Géographie Ancienne et Moderne*" (Paris, Didot, 1866-7, 8°), designed as a sort of supplement to Brunet's well known "*Manuel du Libraire.*" Though prepared for bibliographers, the work will be of great value to any student of geography or history,—as it gives, in the first part, the modern equivalents of the ancient names of European places, and in the second part, the ancient designations, corresponding to modern French names. The only corresponding work, in common use, is that of Bischoff & Möller, but this new publication promises to be even more convenient and complete. With its help, it will be easy for the ordinary reader to identify, at once, the names of places, referred to by writers in the middle ages, and now recognized with difficulty in the nomenclature of modern maps and lexicons.

Behm's "*Geographisches Jahrbuch,*" (Leipsic, 12°) for 1866, is a valuable manual for ready reference in geographical studies. It is designed to convey, in the first place, geographical statistics respecting all the countries of the globe, arranged not alphabetically, but continent-ally,—including the areas and population of provinces and states, according to the latest local authorities. This part is followed by tables of the principal known heights of mountain-peaks and of lakes, measurements of river basins, and select climatic data. Several short articles on the recent progress of geographical science, by different writers, come next; and the volume is concluded, by a collection of tables, designed to facilitate the transfer of geographical measurements, from the terminology of one country to that of another. A work so useful deserves general encouragement.

From recent numbers of Petermann's Journal we gather the following intelligence.

The northernmost land of the Globe.—The publication of Dr. I. I. Hayes's final report on his researches in 1860 and 1861, has given Dr. Petermann occasion to present a series of five maps illustrative of the progress of discovery in the basin north of Baffin's Bay. The first of these shows the base outline of Baffin's Bay as given by Bylot and Baffin in 1616, a rude sketch with scarcely ony details. The second shows the careful coast survey of Ross, two hundred years later, in 1818. Smith's sound is represented as land-locked except on the south. In the third map, Inglefield's passage in 1852 through Smith's sound nearly to 80° N., is exhibited. Then comes a sketch of Dr. Kane's researches extending to Mt. Parry in about lat. 82°, and finally Dr. Hayes's penetration to Cape Union, the most northern point yet attained is about 82° 30′. A full memoir accompanies his maps.

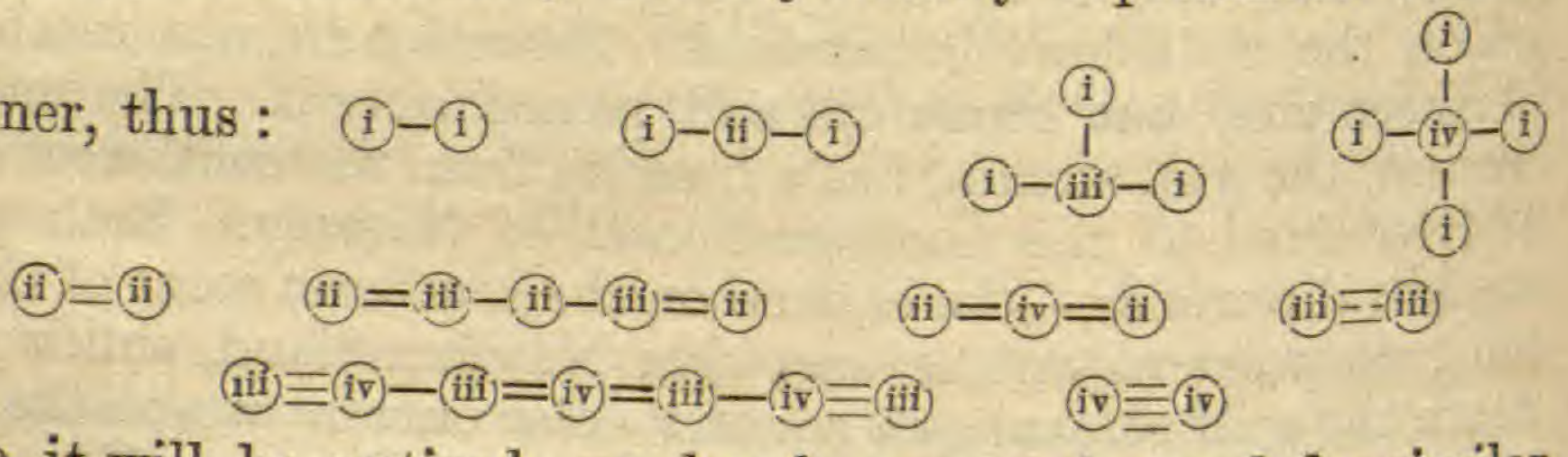
Marine currents of the North Circumpolar basin.—The conclusion of an elaborate paper by A. Mühry, presents the following results of his investigations.

"As an outward current, one stream flows from the east and another from the west along the edge of the Polar basin, where in winter a rim of continental ice is formed, and in summer these currents float this ice away. Thus there exists a floating ice ice-girdle, some twenty or thirty geographical miles in breadth, in which the walfishery is pursued. Scoresby did not reach the northern rim, but Parry did and passed over it. The inward current, the gulf stream, has a breadth from the southwest coast of Greenland to the northwest coast of Norway. Both polar streams dip under,—the eastern on the southeast coast of Greenland, the western on the east side Newfoundland, sinking beneath the gulf stream as a counter polar current where the temperatures are related as 0° to 7° and to 12° Reaum. The counter or anti-polar currents of the gulf stream dip under in four places, on the west side of Nova Zembla, Spitzbergen, Iceland and South Greenland, where the temperatures are related as 3° to 0° Reaum. The fact also indicates that along the middle line of the basin a current flows toward the aperture."

Malden's Island.—This island, (referred to as a deposit of guano by Prof. J. D. Hague, in this Journal II, xxxiv, p. 242,) has been taken possession of by a mercantile house of Melbourne in the name of the British Government. It belongs to a group of small coral islands, (lat. 4° 15′ S., long. 155° W.), which the U. States had previously claimed, and which was subsequently known as the "American Polynesia."

ART. XLII.—*On normal and derived Acids;* by GEORGE F. BARKER.*

THE law of saturation by equivalence, introduced into chemistry by Kekulé, determines at once the formula of every possible binary compound.† Assuming that the simple radicals may be divided into four groups, it will be seen that the number of binary compounds is limited to the following ten classes; monads with monads, as $K'Cl'$; with dyads, as $O''H'_2$; with triads, as $Au'''Cl'_3$; and with tetrads, as $Pt^{iv}I'_4$; dyads with dyads, as $Mg''O''$; with triads, as $As'''_2O''_3$; and with tetrads, as $C^{iv}O''_2$; triads, with triads, as $B'''N'''$; and with tetrads, as $Zr^{iv}_3N'''_4$; and finally tetrads with tetrads, as $Pt^{iv}Si^{iv}$. The number of atoms therefore, which enter into such compounds, is determined by a very simple mathematical law. On this fact rests the possibility of graphic representation. Of the various methods in use, that of A. Crum Brown, in which the atom is represented by a circle, and its equivalence by projecting lines called bonds or units of attraction, is perhaps the best. As every compound body must be saturated, i. e., have all its bonds engaged, the ten classes given above may be very clearly represented in this manner, thus :



Here it will be noticed, no bonds are exchanged by similar atoms; i. e., those of the same element.

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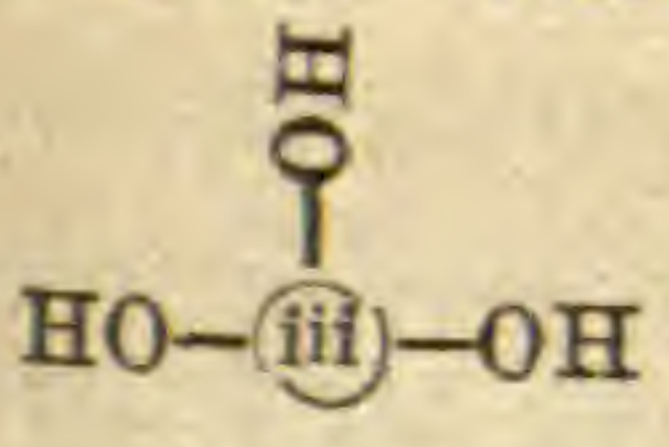
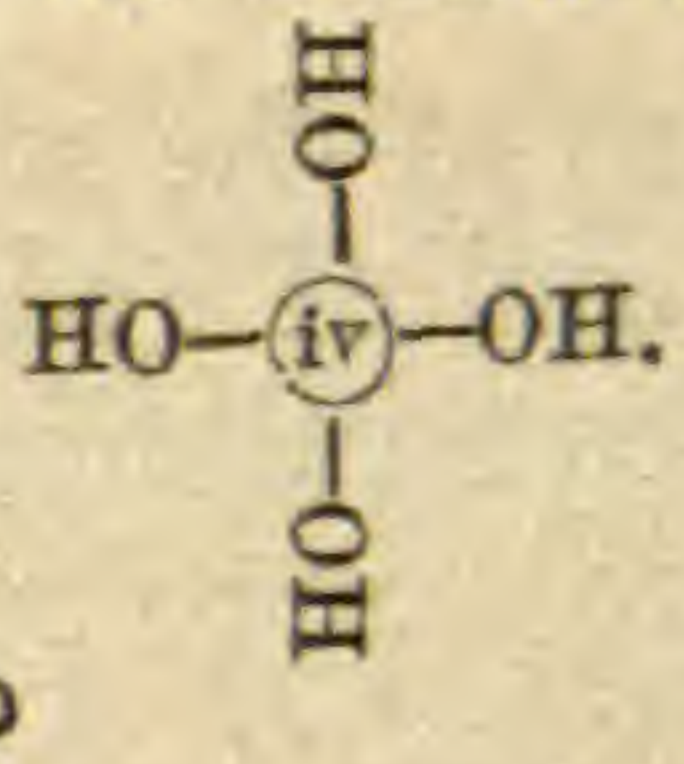
* In this paper, H=1, O=16, S=32, **C**=24, **A**l=55, **S**i=56, etc.

† When two radicals unite together, the number of atoms of each required for mutual saturation, is obtained by dividing the least common multiple of the numbers representing their equivalencies by the equivalence of each. Generally, the number of atoms of each radical is inversely as its equivalence, four triad atoms saturating three tetrads, for example. Atoms thus combined, alternate with each other, the two units of attraction in each exchange, belonging to dissimilar radicals.

When, however, similar atoms unite directly, two units of attraction disappear for each pair of atoms, being occupied in holding these atoms together. Two tetrad atoms thus combined, have therefore an equivalence of six, three such atoms of eight, four of ten, etc. Or, as Kekulé has shown (Lehrbuch, 1861, i, 163), the number of units of attraction left free by the union of any number of carbon atoms is equal to twice the number of such atoms, plus two ($=2n+2$). C. G. Foster has extended this law to all the poly-equivalent radicals (Watts' Dictionary, i, 1007) giving the formula $E=S-2(n-1)$, in which E indicates the group-equivalence, *n* the number of poly-equivalent atoms, and S the sum of their units of attraction. By this formula, the highest number of hydrogen atoms which can be united with ten carbon atoms for example, is $40-2(10-1)=22$, giving the hydrocarbon $C_{10}H_{22}$. From this a series of lower compounds may be formed, each differing from the next higher, by H_2.

If now any of these bonds be left unsatisfied, or in other words, if the chemical edifice represented by the molecule be incomplete, it is evident that the whole structure, whatever its complexity, is capable of entering into combination by its free bond or bonds. Hence in this case, the compound body will act precisely like a simple radical having the same equivalence. Such unsaturated bodies are called compound radicals and their equivalence or combining power is exactly equal to the number of unsatisfied bonds. These compound radicals, therefore, may be used in place of the simple radicals, in the formulas above given; thus forming a new set of compounds, which, since the number of compound radicals possible is almost unlimited, are exceedingly numerous. The compound radicals most in use are those derived from the hydrogen compounds of the different groups of simple radicals, by successive unsaturation. If from the ordinary so-called types, HCl, H_2O, H_3N, H_4C an atom of hydrogen be removed, there is left Cl', $(HO)'$, $(H_2N)'$, $(H_3C)'$, all monad compound radicals. By continuing the process where it is possible, radicals of higher equivalence are thus produced.

With these facts premised, I pass to the subject of the present paper; i. e., the consideration of the bodies which result from the union of the monad compound radical hydryl $(HO)'$ with the simple radicals. Representing H_2O by $\textcircled{H}-\textcircled{O}-\textcircled{H}$, hydryl is $\textcircled{H}-\textcircled{O}-$, which may be represented either by a larger circle or by the letters alone, thus $\mathrm{HO}-$. From the principles above stated, we deduce the formulas $\textcircled{i}-\mathrm{OH}$ $\mathrm{HO}-\textcircled{ii}-\mathrm{OH}$  $\mathrm{HO}-\overset{\overset{\mathrm{HO}}{|}}{\textcircled{iii}}-\mathrm{OH}$ and  $\mathrm{HO}-\underset{\underset{\mathrm{OH}}{|}}{\overset{\overset{\mathrm{HO}}{|}}{\textcircled{iv}}}-\mathrm{OH}$. What is the character of the bodies thus obtained?

A reply to this question becomes possible only by classifying the simple radicals according to their electro-chemical characters. In the method of classification given above, the elements are divided according to the *quantity* of their combining power i. e., to their equivalence; here the division is into positive and negative, according to the *quality* of this combining power. When a *positive* simple radical combines with hydryl, a *base* is produced; when a *negative* simple radical so unites, an *acid* results. If, for example, the vertical columns in the table below, represent the equivalence, increasing from left to right, and the horizontal the electro-chemical character, we may illustrate these statements as follows:—

	Monad.	*Dyad.*	*Triad.*	*Tetrad.*
−	$Cl'(HO)$	$S''(HO)_2$	$B'''(HO)_3$	$C^{iv}(HO)_4$
+	$K'(HO)$	$Ca''(HO)_2$	$Bi'''(HO)_3$	$Zr^{iv}(HO)_4$

The formulas in the upper row represent well known acids, and those in the lower, as well known bases.

It has been thus far assumed that the equivalence of a radical is invariable. But it seems evident that when one element combines with another in more than one proportion, its combining power must be different in the two cases. Thus in stannic oxyd SnO_2 and stannous oxyd SnO; tin is evidently a tetrad in the former case and a dyad in the latter. In all cases, however, the equivalence changes by two, either up or down; it therefore never alters from even to odd or the reverse. A dyad may act as a tetrad or hexad; a monad as a triad, pentad or heptad. Applying this principle now to the compounds of the radicals with hydryl, we notice that the negative radicals vary their equivalence by several stages, forming a series of acids; but that the positive radicals rarely form more than a single series of bases, their equivalence being fixed at a single stage. With negative radicals, we may have for example :—

Monad.	*Dyad.*	*Triad.*	*Tetrad.*
$Cl'(HO)$	$S''(HO)_2$	$P'''(HO)_3$	$Sn^{iv}(HO)_4$
$Cl'''(HO)_3$	$S^{iv}(HO)_4$	$P^{v}(HO)_5$	- - - - -
$Cl^{v}(HO)_5$	$S^{vi}(HO)_6$	- - - -	- - - - -
$Cl^{vii}(HO)_7$	- - - -	- - - -	- - - - -

But the only instance of such changes with the positive radicals, is in the case of the perhydrates of the alkaline earths; as $Ba^{iv}(HO)_4$, $Sr^{iv}(HO)_4$, etc., the composition of which, however, is not fully decided.

I. It will be noticed in the formulas of the acids above given that the number of atoms of oxygen and of hydrogen are equal, and also that they are equal to the equivalence of the radical. Such acids, thus simply derived, I propose to call normal acids. A normal acid then, is one which contains as many atoms of oxygen and of hydrogen as is equal to the equivalence of the radical. They may be designated by prefixing *ortho* to the name of the acid, as proposed by Odling. Fixing now the acid termination *ic* for each group of the negative elements, the other terminations are readily obtained by the ordinary rule. Thus in the chlorine group, the radical in the *ic* acid has an equivalence of five; in the sulphur group, of six; in the nitrogen group, of five; and in the carbon group, of four. The acids in the above tables have consequently the following names :—

$Cl'(HO)$ Ortho-hypochlorous acid, $S''(HO)_2$ Ortho-hyposulphurous acid.
$Cl'''(HO)_3$ Ortho-chlorous acid, $S^{iv}(HO)_4$ Ortho-sulphurous acid.
$Cl^{v}(HO)_5$ Ortho-chloric acid, $S^{vi}(HO)_6$ Ortho-sulphuric acid.
$Cl^{vii}(HO)_7$ Ortho-perchloric acid,

$P'''(HO)_3$ Ortho-phosphorous acid, $Sn^{iv}(HO)_4$ Ortho-stannic acid.
$P^{v}(HO)_5$ Ortho-phosphoric acid.

In all the ortho acids the number of atoms of replaceable hydrogen, and therefore the basicity, is equal to the equivalence of the radical. Quite a number of these acids are known, either in the free state or in their salts. Of these, ortho-hypochlorous $HClO$, and hypo-bromous $HBrO$, ortho-iodous H_3IO_3, ortho-hyposulphurous H_2SO_2, ortho-nitrous H_3NO_3, ortho-boric H_3BO_3, ortho-carbonic H_4CO_4, silicic H_4SiO_4, stannic H_4SnO_4, and titanic H_4TiO_4, and ortho-antimonic acids H_5SbO_5 may be mentioned.

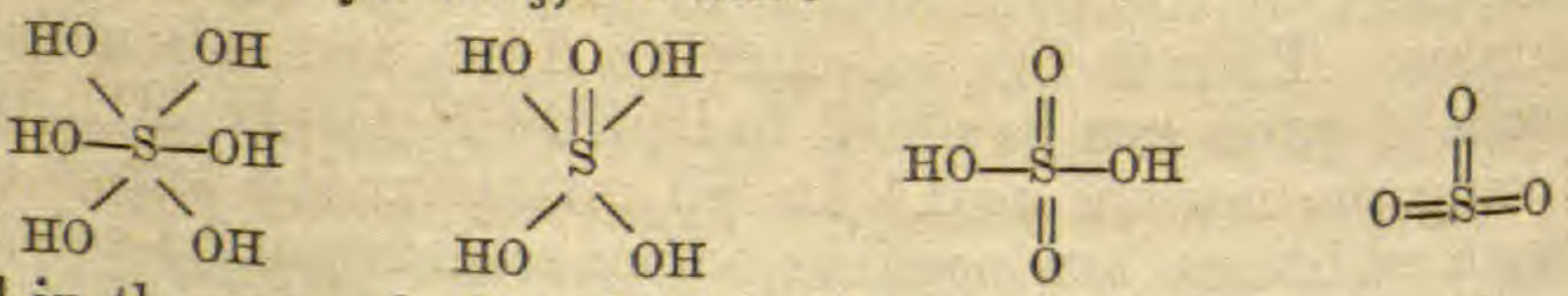
II. But it is at once evident that this simplicity of constitution of the acids is far from universal; indeed the large majority of acids have a composition essentially different. In general, the acids of the chlorine group are monobasic, those of the sulphur group dibasic, those of the nitrogen group mono- or tribasic, and those of the carbon group dibasic. The basicity of an acid containing a single atom of a perissad radical, however, is never even, nor that containing an artiad radical odd.

Now an acid, like any other ternary, may be formed by the union of two binaries; but in the case of acids, one of these binaries is water. Thus Cl_2O hypochlorous oxyd uniting with hydric oxyd H_2O gives $H_2Cl_2O_2$ or $(HClO)_2$, two molecules of ortho-hypochlorous acid. So SO_3 sulphuric oxyd, and H_2O form H_2SO_4, the ordinary sulphuric acid. Conversely, abstraction of the elements of water from an acid yields again the negative oxyd or anhydrid. A false view of this fact it was, which gave rise to the old dualistic formulas, in which water is represented as existing as such in the acids. In all monobasic acids, however, two molecules of the acid are required to furnish one molecule of water; in dibasic acids, one molecule is required, in tribasic acids $\frac{2}{3}$ of a molecule, and in tetrabasic acids $\frac{1}{2}$ a molecule. The number of molecules of water which can be added to a negative oxyd to form an acid is determined by the equivalence of the simple radical which it contains. Thus in SO, sulphur is a dyad, and only a single molecule of water can be added to it, $SO+H_2O=H_2SO_2$, thus producing the normal acid. In SO_2, sulphur is a tetrad and two such additions are possible before reaching ortho-sulphurous acid, $SO_2+H_2O=H_2SO_3$, and $SO_2+(H_2O)_2=H_4SO_4$. In SO_3, sulphur is a hexad and three molecules of water may unite successively, $SO_3+H_2O=H_2SO_4$, $SO_3+(H_2O)_2=H_4SO_5$, and $SO_3+(H_2O)_3=H_6SO_6$, yielding finally the normal acid as before. The reverse process also is readily performed. Indeed, Graham long ago showed that a single molecule of tribasic phosphoric acid by the loss of H_2O, afforded a monobasic phosphoric acid. In the passage then, from the normal acids to the negative oxyds (or anhydrids), there may be as many intermediate acids as successive abstractions of H_2O from the normal acids, will permit. Thus, chlorine may yield

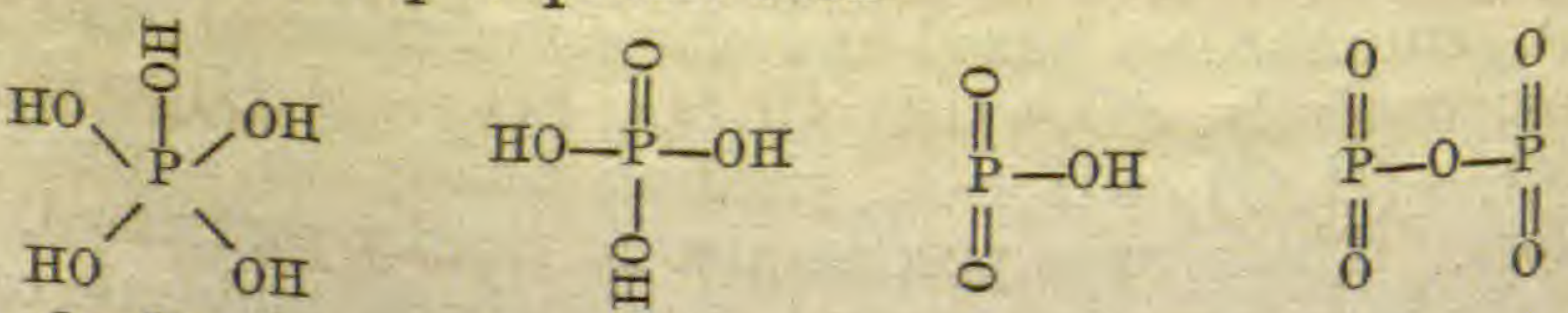
	Monad.	*Triad.*	*Pentad.*	*Heptad.*
Ortho,	$HClO$	H_3ClO_3	H_5ClO_5	H_7ClO_7.
Mono-meta,	....	$H\ ClO_2$	H_3ClO_4	H_5ClO_6.
Di-meta,	....	....	$H\ ClO_3$	H_3ClO_5.
Tri-meta,	....	....	....	$H\ ClO_4$.

To the monobasic phosphoric acid which Graham obtained from the ordinary tribasic acid, by the removal of H_2O, he gave the name meta-phosphoric acid. And although the etymological signification of this prefix has entirely disappeared, yet it is so generally used in the science, that it may be well to retain it; and to define a meta-acid as one formed from an ortho-acid by the loss of one or more molecules of water. Moreover, since there may be several such acids, derived from a single ortho-acid, I propose to prefix the Greek numerals to the meta, in order to distinguish them; as in the above table, where ordinary chloric acid, being two removes from ortho-chloric acid, is named di-meta-chloric acid. Conversely by adding to the meta-acid the number of molecules of water indicated by the Greek numeral prefix, its corresponding ortho-acid is obtained.

From the foregoing considerations, the general conclusion may be drawn, that all acids are either ortho or meta-acids; the ortho-acids being formed by saturating all the free bonds of any negative radical by the monad hydryl; and the meta-acids being derived from these by the loss of the elements of water. It is plain then, that the equivalence of the radical is the same both in the normal acids and in those derived from them; and that they differ in the fact that in the former all the bonds are united to hydryl, while in the latter some of them are saturated by oxygen. This is very clearly represented by the graphic method. In the passage from ortho-sulphuric acid H_6SO_6 to the negative oxyd SO_3, we have



and in the case of phosphoric acid—

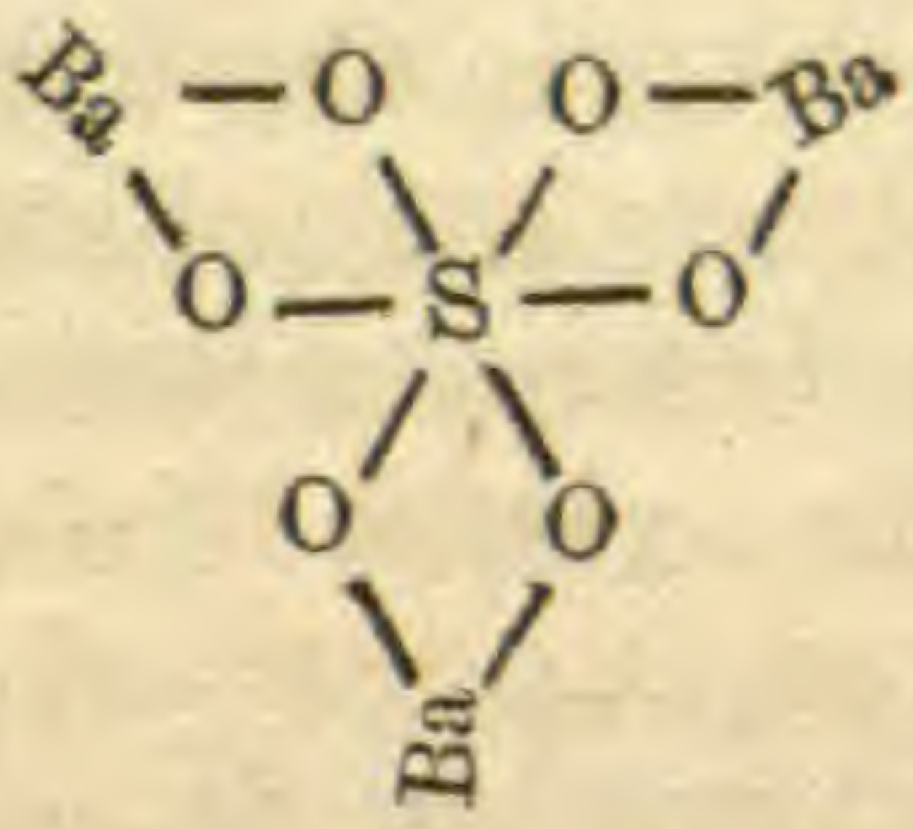


where finally, two molecules together losing H_2O, form phosphoric oxyd P_2O_5. It will be noticed that the tribasic acid, called by Odling ortho-phosphoric acid, is really mono-meta-phosphoric acid; while the common meta form is a di-meta-acid.

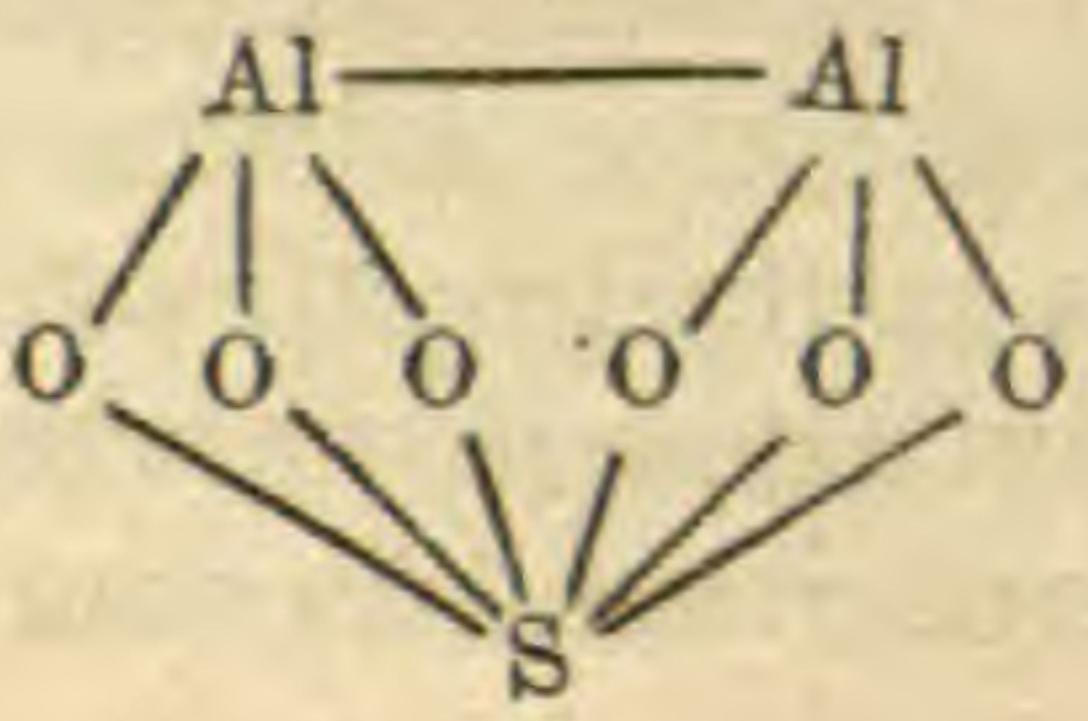
The above facts, we may remark in passing, throw much light on the manner of writing rational formulas. In all ternary compounds properly so called, the positive and the negative radicals are united by oxygen; indeed, this is the definition of an acid, a base and a salt. In all normal acids and their salts all the oxygen performs a linking function, thus:—

Potassic ortho-sulphate.

Baric ortho-sulphate.

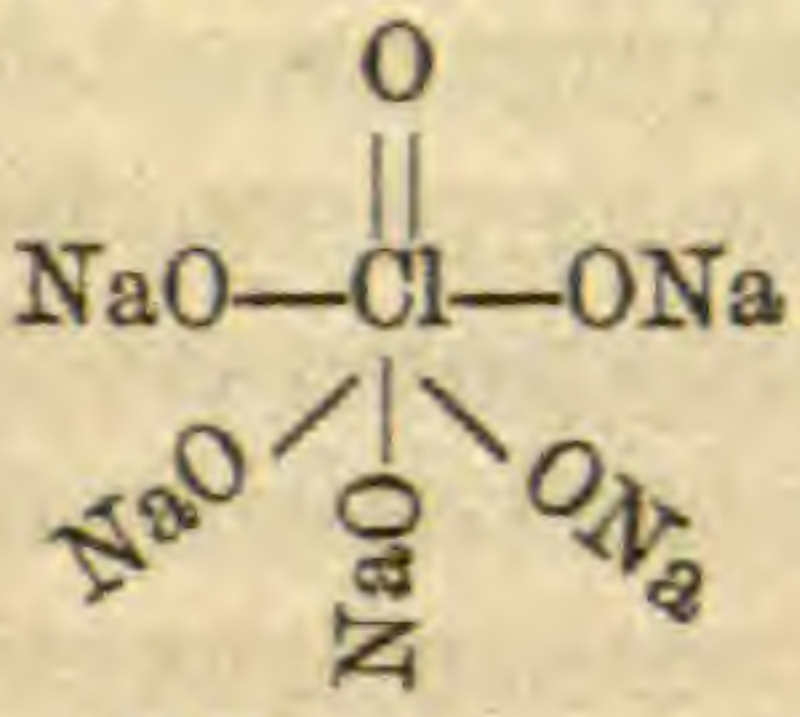


Aluminic ortho-sulphate.

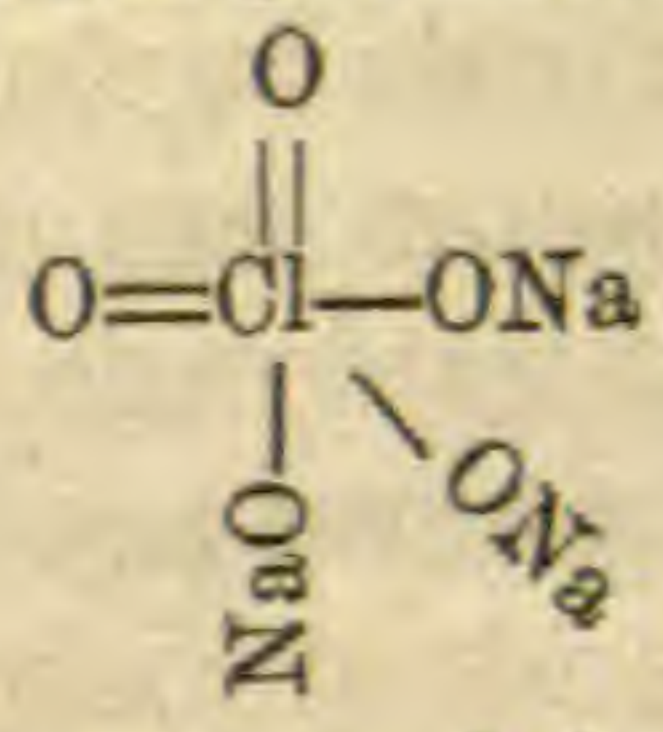


But in the derived or meta-acids a part of the oxygen is united with the radical by both its bonds, and hence takes no part in binding the radicals together.* In all the mono-meta acids one atom of oxygen is thus united, in the di-meta acids two, etc. For example,

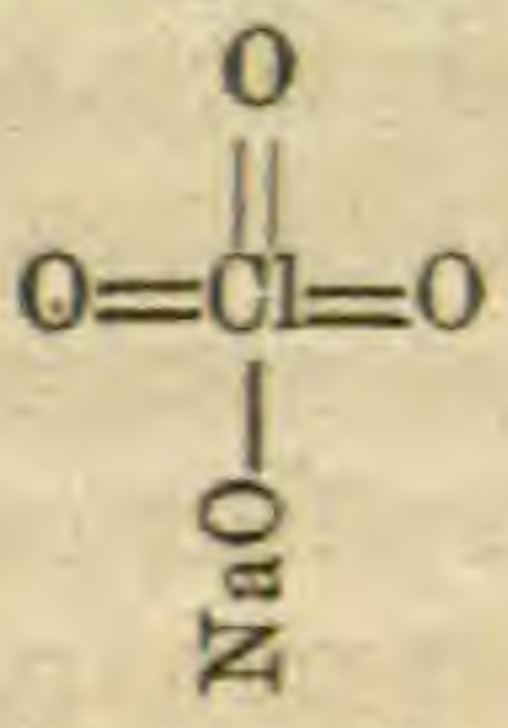
Sodic mono-meta-perchlorate.



Sodic di-meta-perchlorate.



Sodic tri-meta-perchlorate.



This difference may be expressed by the ordinary formulas, thus: ortho salts $Cl—OK$, $S=(OK)_2$, $B\equiv(OK)_3$ etc.; meta, $(PO)\equiv O_3Bi'''$, $(NO_2)—OK$, $(ClO_3)—OAg$, etc; or better in the form of the early typical formulas $\left.\begin{matrix}Cl'\\K\end{matrix}\right\}O$, $\left.\begin{matrix}S''\\Na_2\end{matrix}\right\}O_2$, $\left.\begin{matrix}B'''\\K_3\end{matrix}\right\}O_3$, and $\left.\begin{matrix}(PO)'''\\Bi'''\end{matrix}\right\}O_3$, $\left.\begin{matrix}(NO_2)'\\K\end{matrix}\right\}O$, $\left.\begin{matrix}(ClO_3)'\\Ag\end{matrix}\right\}O$. Hence it appears desirable that the form of the water type should be retained for rational formulas, since by it, this essential difference in the function of the oxygen may be readily indicated. $\left.\begin{matrix}(PO_2)'\\Cs\end{matrix}\right\}O$ designates at once cæsic di-meta-phosphate, $\left.\begin{matrix}(NO)'''\\Bi'''\end{matrix}\right\}O_3$ bismuthic mono-meta nitrate, $\left.\begin{matrix}(SO_2)''\\Mg''\end{matrix}\right\}O_2$ magnesic di-meta-sulphate, $\left.\begin{matrix}(SO)^{iv}\\Pt^{iv}\end{matrix}\right\}O_4$ platinic mono-meta-sulphate, $\left.\begin{matrix}(SO)''\\Na_2\end{matrix}\right\}O_2$

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* This direct union is proved by the fact that this oxygen may be replaced by a radical of no uniting power, like the monad chlorine, for example, without breaking up the molecule; while the oxygen which unites the radicals to each other, cannot be so replaced without decomposing the molecule.

sodic mono-meta-sulphite, $\left.\begin{matrix}(ClO_3)'\\Rb\end{matrix}\right\}O$, rubidic tri-meta-perchlorate, etc.

With the knowledge of the constitution of the acids above given, it may be interesting to examine the various groups of acid-forming or negative radicals, to see how far they conform to the law. Commencing with the monads, the chlorine group is the only one which forms acids. All the possible ortho and meta acids of chlorine are given in the table, page 388. Of these, those in italics, all of which are monobasic, are known with certainty, though polybasic acids of chlorine have been supposed, on experimental grounds, to exist.* In the case of iodine, however, mono-meta-iodic acid H_3IO_4, or $\left.\begin{matrix}(IO)'''\\H_3\end{matrix}\right\}O_3$, and di-meta-iodic acid HIO_3 or $\left.\begin{matrix}(IO_2)'\\H\end{matrix}\right\}O$ are known; so also are mono-meta-periodic acid H_5IO_6, di-meta-periodic acid H_3IO_5, and tri-meta-periodic acid HIO_4. Ortho-hypoiodous acid HIO, is supposed to exist. The acids of bromine have been but little studied; ortho-hypobromous acid HBrO, and di-meta-bromic acid $HBrO_3$ are the only ones satisfactorily established.

The dyad negative radicals include the sulphur and the iron groups. The substances composing the latter group, however, form bases when they act as dyads, are ambiguous as tetrads, and only form acids when they are hexads. Selenium and tellurium form no compounds which are not yielded by sulphur. The latter may stand, therefore, as the representative of both groups. It may form

	Dyad.	*Tetrad.*	*Hexad.*
Ortho-hyposulphurous	H_2SO_2.	sulphurous H_4SO_4.	sulphuric H_6SO_6
Mono-meta	......	H_2SO_3	H_4SO_5
Di-meta	......	......	H_2SO_4

The three dibasic acids above given are the ordinary ones. But the two hydrates of sulphuric acid, so called, correspond to H_6SO_6 and H_4SO_5; and from these are obtained similar salts, as Hg''_3SO_6, and Zn''_2SO_5. The acids formed by the iron group are similar to those of hexad sulphur, the di-meta form being the more common; as in H_2CrO_4, H_2MnO_4, and H_2FeO_4. Chromium, however, forms acids, whose salts are well known, corresponding to the three sulphuric acids above given. With mercury and bismuth, there are the ortho-chromates Hg''_3CrO_6 and Bi'''_2CrO_6; and with lead, the mono-meta-chromate Pb''_2CrO_5. Manganese in its tetrad stage, appears capable of forming a mono-meta acid, corresponding to

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* Crystallized hydric perchlorate, according to Roscoe, is H_3ClO_5 the di-meta form.

H_2SO^3. No true permanganic acid is known; since the acid so-called does not contain the metal as an octad. If its formula be written $HMnO_4$, monobasic, as the isomorphism of its salts with the perchlorates would seem to require, then manganese must be a heptad like chlorine; nor do we escape from this conclusion by writing it $H_2Mn_2O_8$, as will be seen farther on.

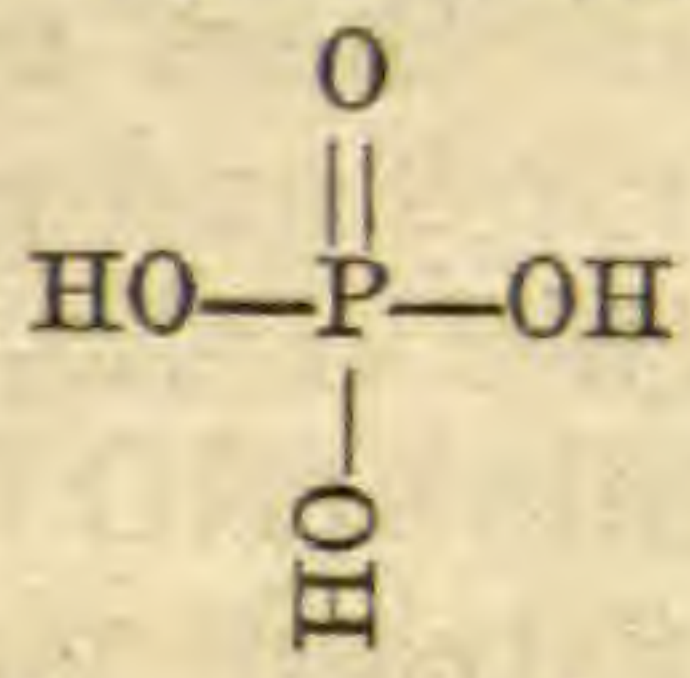
The acids of triad radicals may be divided into two groups; those of boron and gold, which have no higher equivalence: and those of nitrogen, phosphorus, arsenic, antimony, and bismuth, which have a quinquivalent stage. Of the former, boron forms an ortho-acid H_3BO_3 and a mono-meta-acid HBO_2; gold only a mono-meta-auric acid, $HAuO_2$. The acids of the nitrogen group may be represented as follows:

	Triad.		*Pentad.*
Ortho-nitrous	H_3NO_3	nitric	H_5NO_5
Mono-meta	$H\ NO_2$		H_3NO_4
Di-meta	......		$H\ NO_3$

Salts have been obtained corresponding to all these acids of nitrogen; as plumbic ortho-nitrite $Pb''_3(NO_3)_2$, and potassic mono-meta nitrite KNO_2; dihydro-bismuthic ortho-nitrate $H_2Bi'''NO_5$, magnesic mono-meta-nitrate $Mg''_3(NO_4)_2$ and sodic di-meta-nitrate $NaNO_3$. No acid of triad phosphorus is known, if we except the calcic ortho-phosphite $Ca''_3(PO_3)_2$, corresponding to it. As quinquivalent however, all the above acids of phosphorus are known; the mineral libethenite is hydro-di-cupric ortho-phosphate HCu''_2PO_5; and triple phosphate dried at 100° C., has the formula $H_2(NH_4)MgPO_5$, di-hydro-ammonio-magnesic ortho-phosphate. Similar salts of iron and manganese have been obtained. The mono-meta-phosphoric acid H_3PO_4 is the ordinary tribasic form (Odling's ortho-acid), and the di-meta acid is the common monobasic or meta acid of Graham. It may here be remarked that the acids, called hypophosphorous and phosphorous, are misnamed, since the radical phosphorus is not trivalent in the latter and univalent in the former as analogy with the other acids, and indeed as the principles of nomenclature would require; but as Frankland has represented, both these acids contain phosphorus as a pentad. If the principles above stated be correct, it is evident that the number of atoms of basic hydrogen can never exceed those of the oxygen by which it is linked to the acid radical. In H_3PO_2 the hydrogen is in excess, and it is at once apparent that the acid cannot be tribasic; that one atom of the hydrogen at least, must be united directly with the phosphorus. Experiment shows us that in fact two atoms of hydrogen are thus directly united, the acid being monobasic. Its rational formula, therefore, is

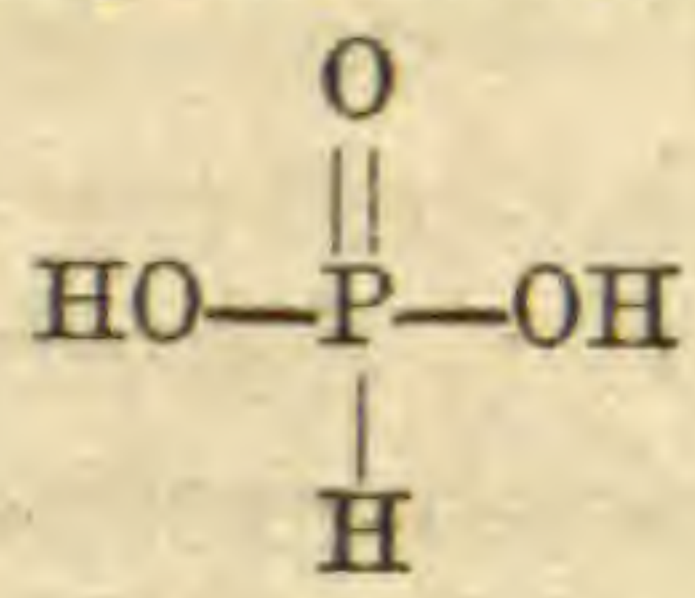
$\left.\begin{matrix}(H_2PO)'\\H\end{matrix}\right\}O$, and it may be viewed as di-meta-phosphoric acid $\left.\begin{matrix}(PO_2)'\\H\end{matrix}\right\}O$, in the radical of which H_2 has replaced O. In phosphorous acid H_3PO_3, a single atom of hydrogen being united directly to the phosphorus, the other two are replaceable by basic metals, yielding acid and neutral salts, having the formulas $\left.\begin{matrix}(HPO)''\\HR\end{matrix}\right\}O_2$ and $\left.\begin{matrix}(HPO)''\\R_2\end{matrix}\right\}O_2$ as Rammelsberg has shown. All three hydrogen atoms may be replaced by the alcoholic radicals, forming neutral ethers; but only two atoms of this radical—those which have replaced the basic hydrogen—can be exchanged for a metal, to form salts. The third atom, replacing as it does, the alcoholic hydrogen, is still retained, forming alcoholic phosphorous acids. The constitution of these acids may be graphically represented thus:

Phosphoric acid.



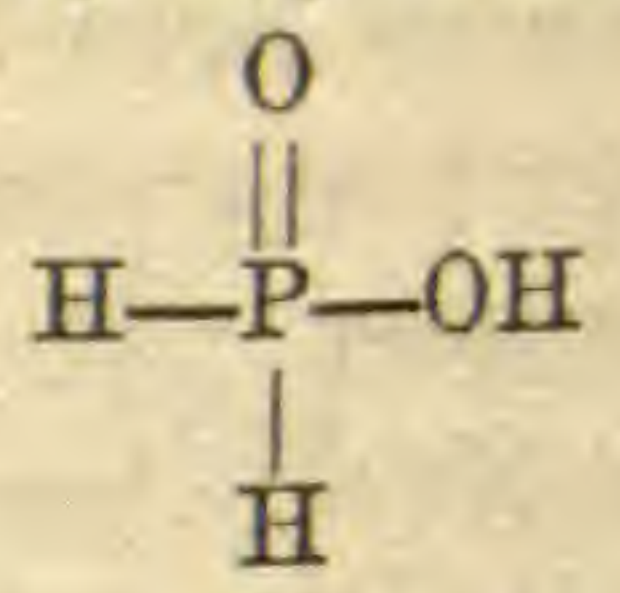
$\mathrm{HO{-}\underset{\underset{OH}{|}}{\overset{\overset{O}{\|}}{P}}{-}OH}$

Phosphorous acid.



$\mathrm{HO{-}\underset{\underset{H}{|}}{\overset{\overset{O}{\|}}{P}}{-}OH}$

Hypophosphorous acid.



$\mathrm{H{-}\underset{\underset{H}{|}}{\overset{\overset{O}{\|}}{P}}{-}OH}$

Since they are formed from mono-meta-phosphoric acid by replacing hydryl by hydrogen, they resemble the phosphoric chlorhydrines, to be considered farther on.

Acid compounds of arsenic exist, corresponding to all the forms given above. Plumbic ortho-arsenite $Pb''_3(AsO_3)_2$, hydro-cupric ortho-arsenite $HCu''AsO_3$, and di-hydro-potassic ortho-arsenite H_2KAsO_3; plumbic and potassic mono-meta-arsenites, $Pb''(AsO_2)_2$ and $KAsO_2$; hydro-di-cupric ortho-arsenate HCu''_2AsO_5 (olivenite), sodic mono-meta-arsenate Na_3AsO_4, and potassic di-meta-arsenate $KAsO_3$, are examples. Antimony forms argentic ortho-sulphantimonite Ag_3SbS_3 (pyrargyrite), argentic mono-meta-sulphantimonite $AgSbS_2$ (miargyrite) and mono-meta-antimonous acid $HSbO_2$; ortho-antimonic acid H_5SbO_5, mono-meta antimonic acid H_3SbO_4, (and the salts $Pb''_3(SbO_4)_2$ and K_3SbS_4) di-meta-antimonic acid $HSbO_3$ and potassic di-meta-antimonate $KSbO_3$. The compounds of bismuth are little known. Kobellite is a plumbic ortho-sulph-bismuthite $Pb''_3\,(BiS_3)_2$; and di-meta-bismuthic acid $HBiO_3$ has also been obtained.

The negative radicals of the tetrad group include carbon, silicon, tin and titanium. Carbon may form

Ortho-carbonous acid	H_2CO_2	carbonic	H_4CO_4
Mono-meta	......		H_2CO_3

Of the first, there is evidence to believe it is represented by formic acid.[*] Both ortho-and meta-carbonic acids form numerous salts. Calcic ortho-carbonate Ca''_2CO_4, cupric ortho-carbonate Cu''_2CO_4+aq (malachite) and hydro-tri-cupric ortho-carbonate $H_2Cu''_3(CO_4)_2$, (azurite) are examples of the former; and the common carbonates K_2CO_3, $BaCO_3$, etc., of the latter. The division of the silicates into ortho-and meta-salts, has been very clearly represented by Prof. Dana in the last number of this Journal. Ortho- and meta-stannates and titanates are well known compounds.

Of radicals having a higher equivalence, the pentads tantalum and columbium, forming a series of acids similar to quinquivalent phosphorus, and the hexads molybdenum, vanadium and tungsten, whose acids correspond to those of sexivalent sulphur, may here be mentioned.

The compounds thus far considered are derived from negative radicals; but, as already intimated, positive elements form a similar series of bodies. Since the equivalence of positive radicals rarely varies, but a single ortho-base of the same radical is known. Of ortho-bases, ortho-potassic base HKO, ortho-calcic base H_2CaO_2, and ortho-zirconic base H_4ZrO_4, are examples. The mineral pyrochroite is ortho-manganous base, H_2MnO_2 and brucite is ortho-magnesic base H_2MgO_2. From these, by the loss of the elements of water come the meta-bases, as meta-zirconic base H_2ZrO_3 but they are few in number. The perhydrates of the alkaline earths, so called, are probably meta-bases; as mono-meta-baric base H_2BaO_3 or $\left.\begin{matrix}(BaO)''\\ H_2\end{matrix}\right\}O_2$, mono-meta-calcic base H_2CaO_3 or $\left.\begin{matrix}(CaO)''\\ H_2\end{matrix}\right\}O_2$.

III. There is a third class of acids which is not included in either of the divisions above given. I refer to those which contain more than a single atom of the radical. Since they are derived from the ortho-acids, they are evidently meta-acids. The most familiar example is pyrophosphoric acid, $H_4P_2O_7$, derived from two molecules of ortho-phosphoric acid H_5PO_5 by the loss of the elements of three molecules of water, $H_{10}P_2O_{10}-(H_2O)_3=H_4P_2O_7$. A simple method of naming these acids is suggested by the principles already given. All acids derived from two molecules of phosphoric acid, for example, may be called di-phosphoric acids;[†] and the number of

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[*] This Journal, II, xliv, 263, Sept. 1867.

[†] As has already been proposed by Wurtz (Chemical Philosophy, London, 1867, 159), Schiff (Ann. Ch. Pharm., IV. Suppl., 30), Naquet (Chimie, 2d ed. i, 172), Frankland (Lecture notes, 103), Rammelsberg (Chemie, Berlin, 1867, 292), (Weltzien, Syst. Uebers. der Silicate, Giessen, 1864,) and others, though in a modified

molecules of water lost, to yield the meta-acid may be indicated by a numeral prefix to the meta, as above. Hence, as pyrophosphoric acid becomes tri-meta-di-phosphoric acid. A rule for naming may be given, as follows ; Prefix to the name of the acid, the numeral corresponding to the number of atoms of the negative radical contained in the formula. Then add the elements of water until the oxygen and the hydrogen atoms are equal; the numeral indicating the number of molecules of water thus employed, is to be prefixed to the word meta, placed before the name of the acid. For example, Fleitmann and Henneberg obtained two soda salts, referable to the acids $H_6P_4O_{13}$ and $H_{12}P_{10}O_{31}$. The first is a tetra-phosphoric acid, the ortho-acid of which is reproduced by adding to it seven molecules of water. The second is derived from deca-phosphoric acid, by the loss of nineteen molecules of water. Hence the salts are sodic hepta-meta-tetra-phosphate and sodic enneadeca-meta-deca-phosphate; meaning that the former is derived from four molecules of the ortho-acid by the loss of seven molecules of water, and the latter is nineteen removes from ten acid molecules. These acids and their derivatives are exceedingly numerous. Wurtz is inclined to view them as accumulated bodies, similar to the polyethylenic alcohols; stating that as PbO may be added to $\left.\begin{matrix}Pb''\\H_2\end{matrix}\right\}O_2$, producing $\left.\begin{matrix}Pb''\\Pb''\\H_2\end{matrix}\right\}O_3$ and $\left.\begin{matrix}Pb''\\Pb''\\Pb''\\H_2\end{matrix}\right\}O^4$, so to $\left.\begin{matrix}(SO_2)''\\H_2\end{matrix}\right\}O_2$, $(SO_2)''O$ may be added, yielding the fuming or Nordhausen sulphuric acid $\left.\begin{matrix}(SO_2)''\\(SO_2)''\\H_2\end{matrix}\right\}O_3$ equal to $H_2S_2O_7$, our penta-meta-di-sulphuric acid. This process, however, leaves the basicity of the acid unaltered ; and hence is insufficient in many cases.

The number of these acids may be illustrated by a table, showing the di- and tri-acids of the tetrad silicon, and of the pentad phosphorus, with the various meta acids derived from them, as follows :

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sense. In the places above cited these authors speak of di-silicic acid, referring apparently, to any acid containing two silicon atoms. The normal di-silicic acid of these writers, however, is $H_6Si_2O_7$; whereas my di-silicic acid is $H_8Si_2O_8$, two molecules of ortho-silicic acid, from which by the loss of H_2O, is obtained $H_2Si_2O_7$, mono-meta-di-silicic acid.

	Di-acid.		*Tri-acid.*	
	Tetrad.	*Pentad.*	*Tetrad.*	*Pentad.*
Ortho,	$H_8Si_2O_8$*	$H_{10}P_2O_{10}$*	$H_{12}Si_3O_{12}$*	$H_{15}P_3O_{15}$*
Mono-meta,	$H_6Si_2O_7$	$H_8P_2O_9$	$H_{10}Si_3O_{11}$	$H_{13}P_3O_{14}$
Di-meta,	$H_4Si_2O_6$*	$H_6P_2O_8$*	$H_8Si_3O_{10}$	$H_{11}P_3O_{13}$
Tri-meta,	$H_2Si_2O_5$	$H_4P_2O_7$	$H_6Si_3O_9$*	$H_9P_3O_{12}$*
Tetra-meta,	Si_2O_4	$H_2P_2O_6$*	$H_4Si_3O_8$	$H_7P_3O_{11}$
Penta-meta,		P_2O_5	$H_2Si_3O_7$	$H_5P_3O_{10}$
Hexa-meta,			Si_3O_6	$H_3P_3O_9$*
Hepta-meta,				$H\ P_3O_8$

A few examples of well known compounds, formed in this way, will make the preceding remarks clear.

Cupric mono-meta-di-arsenite,	$Cu_2As_2O_5$ (Scheele's green)
Plumbic tri-meta-di-arsenate,	$Pb_2As_2O_7$
Ferric tri-meta-di-sulphate,	$Fe^{vi}S_2O_9$
Potassic penta-meta-di-chromate,	$K_2Cr_2O_7$
Penta-meta-di-periodic acid,	$H_4I_2O_9$
Di-hydro-plumbic mono-meta-tri-carbonate,	$H_2Pb_4C_3O_{11}$ (white lead).
Hepta-meta-tri-iodic acid,	HI_3O_8
Plumbic tri-meta-tetra-sulphantimonite,	$Pb_3Sb_4S_9$ (Jamesonite).
Sodic penta-meta-tetra-borate,	$Na_2B_4O_7$ (borax).
Potassic ennea-meta-tetra-iodate,	$K_2I_4O_{11}$
Ennea-meta-tetra-periodic acid,	$H_{10}I_4O_{19}$
Plumbic penta-meta-hexa-sulphantimonite,	$Pb_4Sb_6S_{13}$ (plagionite).
Magnesic ennea-meta-octo-borate,	$Mg_3B_8O_{15}$ (boracite).

IV. In the formulas of these and similar substances the atoms of the negative radical are united to each other by oxygen, as Frankland has already shown for many of them.† It is evident, however, that these atoms may unite directly together, in which case two units of attraction in each pair of atoms will be occupied in uniting them. The equivalence of the group will then be represented by the law of saturation $E=S-2(n-1)$, already given. Certain artiads have a particular tendency to combine in this manner; as mercury in Hg_2Cl_2 and copper in Cu_2H_2; and particularly the iron group of metals, which were long supposed to be triads for this reason. Two atoms of a

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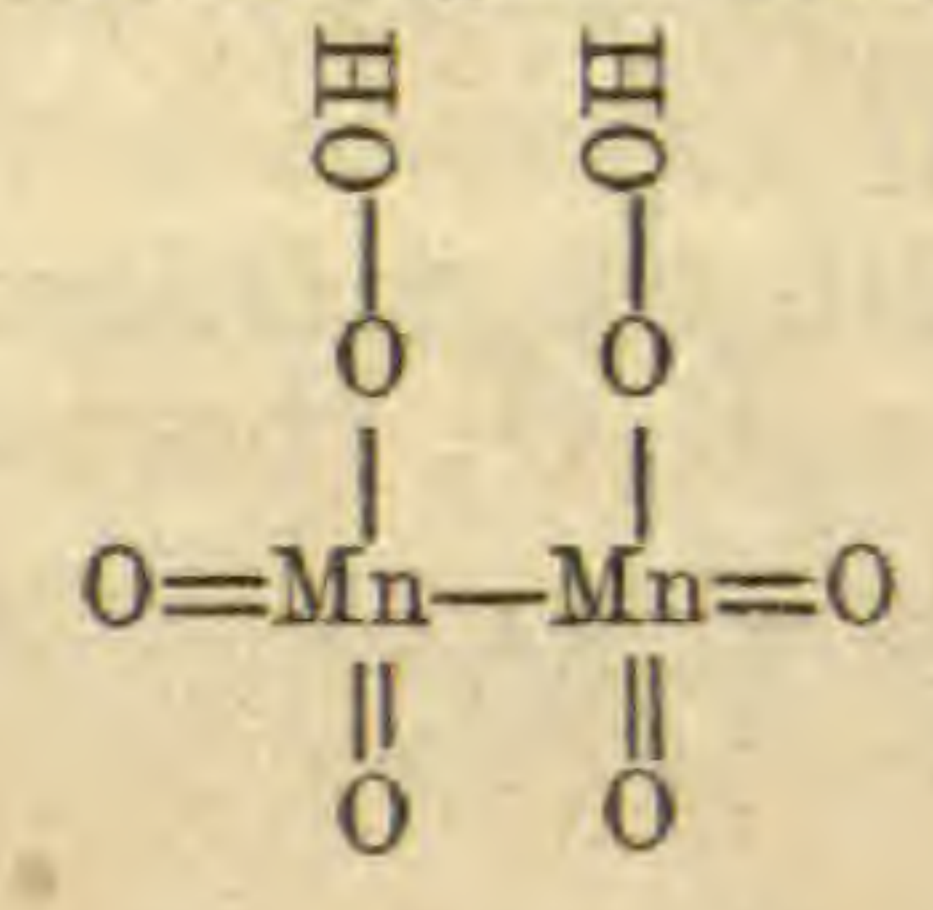
* The compounds thus indicated are not distinct acids, but are multiples of the simple ortho or meta forms. See Wurtz' Chemical Philosophy, London, 1867, 158, note. It may here be remarked that monobasic phosphoric acid is capable of forming a series of polymeric compounds corresponding to the multiples given above. With silver, for example, $Ag_2P_2O_6$, $Ag_3P_3O_9$ and $Ag_6P_6O_{18}$ have been obtained. They are called di-, tri- and hexa-meta-phosphates, respectively. In the table, the first appears as tetra-meta-di-phosphate, and the second as hexa-meta-tri-phosphate.

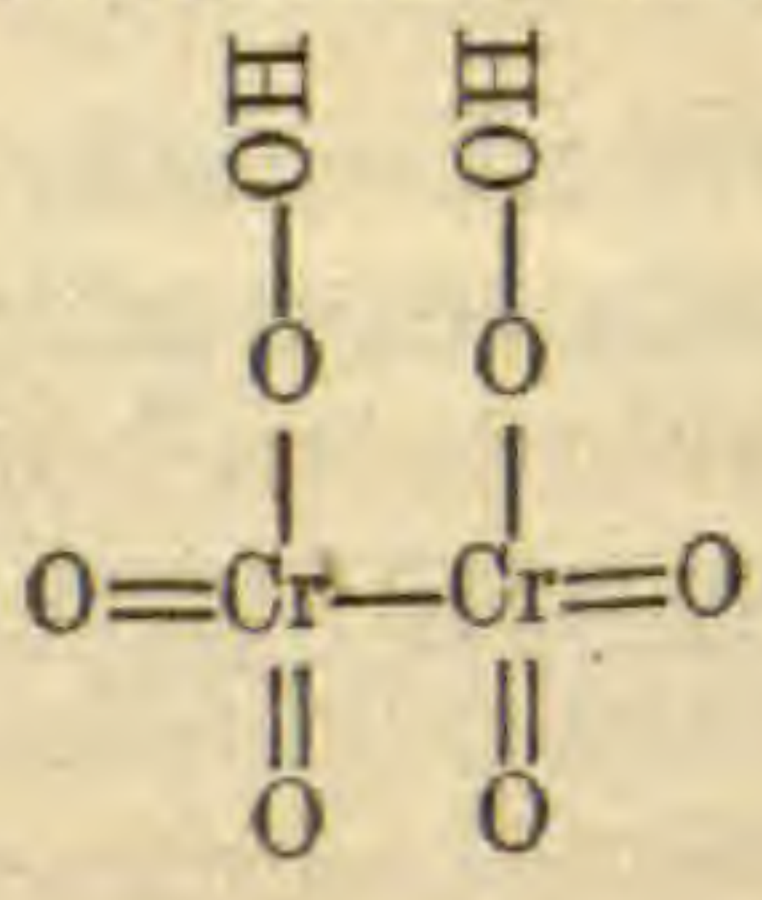
† Lecture notes for chemical students, London, 1866.

tetrad directly united, lose two bonds, and together act as a hexad. Fe_2Cl_6 or $\mathbf{Fe}^{vi}Cl_6$ $\mathbf{Mn}^{vi}O_3$, $\mathbf{Co}^{vi}S_3$, $\mathbf{Cr}^{vi}Cl_6$, etc., are examples of binaries so formed. With hydryl the compounds produced are quite numerous, and many of them occur as minerals. Thus ortho-ferric base $H_6\mathbf{Fe}^{vi}O_6$ is limonite, and ortho-aluminic base $H_6\mathbf{Al}^{vi}O_6$ is gibbsite. From these are derived the meta-bases; as from $H_6\mathbf{Al}^{vi}O_6$ comes $H_4\mathbf{Al}^{vi}O_5$ mono-meta-aluminic base, and $H_2\mathbf{Al}^{vi}O_4$ di-meta-aluminic base, diaspore. So from limonite $H_6\mathbf{Fe}^{vi}O_6$ may be obtained $H_4\mathbf{Fe}^{vi}O_5$ mono-meta-ferric base (xanthosiderite) and $H_2\mathbf{Fe}^{vi}O_4$ di-meta-ferric base (Göthite). Manganite $H_2\mathbf{Mn}^{vi}O_4$ is di-meta-manganic base. Permanganic and perchromic acids, $H_2Mn_2O_8$ and $H_2Cr_2O_8$, as was stated on page 389, must contain their radicals as heptads, if their atoms are united by oxygen. Frankland, however, to avoid a violation of the fundamental law of saturation, supposes that the manganese and chromium atoms are directly united, and makes an oxygen atom intervene between each negative atom and the hydryl, thus:—

Permanganic acid.



Perchromic acid.



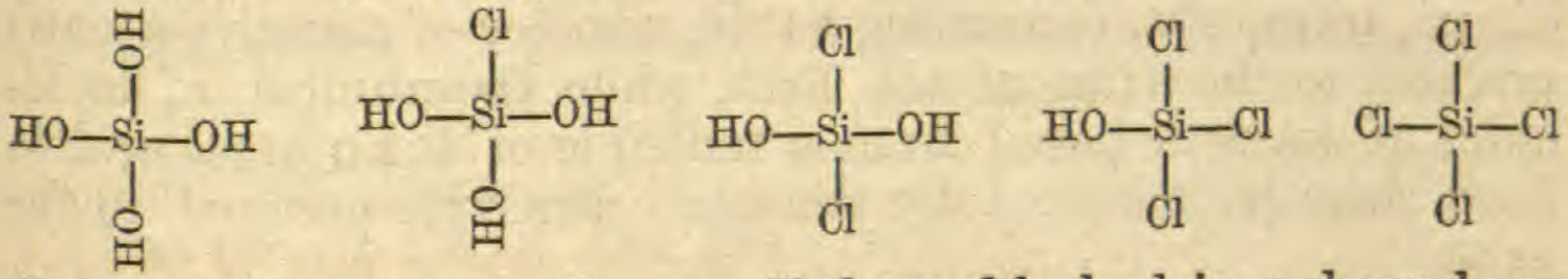
On either supposition, their constitution is anomalous.

The same direct union takes place with the carbon group of tetrads forming $\mathbf{C}^{vi}Cl_6$, $\mathbf{Sn}^{vi}O_3$, $\mathbf{Ti}^{vi}N_2$, etc. With hydryl, therefore, such a series of compounds as the following, becomes possible.

	Carbon.	*Silicon.*
Ortho-oxalic acid,	$H_6\mathbf{C}^{vi}O_6$	$H_6\mathbf{Si}^{vi}O^6$
Mono-meta-oxalic acid,	$H_4\mathbf{C}^{vi}O_5$	$H_4\mathbf{Si}^{vi}O_5$
Di-meta-oxalic acid,	$H_2\mathbf{C}^{vi}O_4$	$H_2\mathbf{Si}^{vi}O_4$
Di-carbonic tri-oxyd,	$\mathbf{C}^{vi}O_3$	$\mathbf{Si}^{vi}O_3$

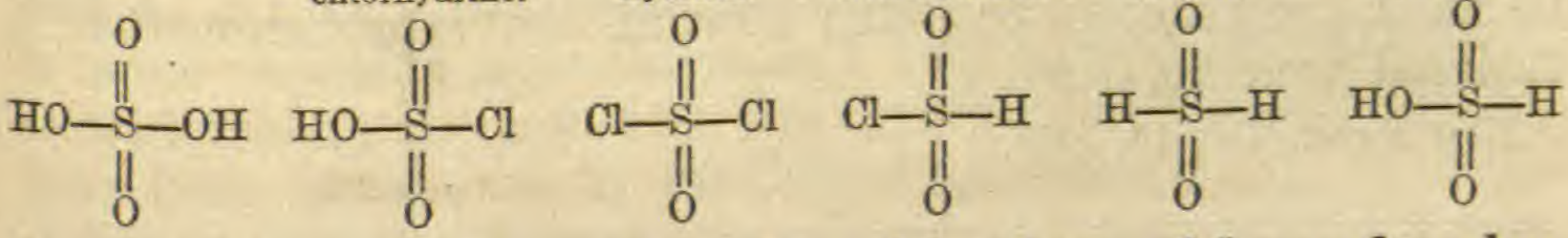
In the carbon series, the di-meta form is ordinary oxalic acid, from which the group may be named. The ortho-oxalic acid is represented in plumbic ortho-oxalate $Pb''_3C^{vi}O_6$ but the mono-meta acid seems to be unknown. The silicon compounds do not appear to be known with certainty, although several observers have reported the discovery of a di-silicic tri-oxyd (sesquioxyd of silicon) with some of the hydrates belonging to it.

The view which has now been given, of the constitution of acids and bases, renders very simple the relation of these bodies to the chlorhydrines, so-called. An acid being converted into a chlorhydrine by exchanging its hydryl (HO)′ for the monad chlorine (from which fact the word chlorhydrine comes) it is evident that there may be as many chlorhydrines obtained from a given ortho or meta acid, as is equal to the number of atoms of its basic hydrogen, less one, the final product being the chlorid of the radical. Thus with ortho-silicic acid, there may be



Hydric silicate.	Mono-chlorhydrine.	Di-chlorhydrine.	Tri-chlorhydrine.	Silicic chlorid.
$HO-\underset{OH}{\overset{OH}{Si}}-OH$	$HO-\underset{OH}{\overset{Cl}{Si}}-OH$	$HO-\underset{Cl}{\overset{Cl}{Si}}-OH$	$HO-\underset{Cl}{\overset{Cl}{Si}}-Cl$	$Cl-\underset{Cl}{\overset{Cl}{Si}}-Cl$

Compounds corresponding to all these chlorhydrines, have been obtained by Friedel and Crafts.* If the acid be a meta-acid, the radical is partially saturated by oxygen, and the final result is a so-called oxychlorid (the chlor-aldehyd of Odling); the true aldehyd being a similar body, containing hydrogen in place of chlorine. For example, di-meta-sulphuric acid may form in this way the following bodies:



Acid.	Mono-chlorhydrine.	Dichlor-hydrine.	Hydro-chlorhydrine.	Di-hydro-hydrine.	Mono-hydro-hydrine.
$HO-\underset{O}{\overset{O}{S}}-OH$	$HO-\underset{O}{\overset{O}{S}}-Cl$	$Cl-\underset{O}{\overset{O}{S}}-Cl$	$Cl-\underset{O}{\overset{O}{S}}-H$	$H-\underset{O}{\overset{O}{S}}-H$	$HO-\underset{O}{\overset{O}{S}}-H$

A comparison of these formulas with those of hypophosphorous and phosphorous acids on page 392, will make clear the relation of these acids to mono-meta-phosphoric acid, by showing that they are its hydro-hydrines, the last of the series, H_3PO phosphoric aldehyd, not being yet known.

The results given in the foregoing pages may be briefly recapitulated. I have attempted to show:

1. That all the bonds of any simple radical may be saturated by the monad hydryl.

2. That the compounds thus formed, are determined by the electro-chemical character of the radical; being acids when it is negative, and bases when it is positive.

3. That acids and bases so formed, being evidently normal, are conveniently designated by the prefix *ortho*.

4. That the equivalence of negative radicals varies through several stages, while that of positive rarely changes. And hence, that there may be a series of ortho acids from a given negative radical, but only a single base from a positive one.

5. That by the removal of the elements of water from a normal or ortho acid, a derived acid is produced, which may be indicated by the prefix *meta*.

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* This Journal, II, xliii, 155, March, 1867.

6. That when there are several such derivatives, the Greek numeral prefixes di, tri, tetra, etc., may be used to indicate the number of molecules of water removed from the ortho acid to yield the meta-form.

7. That intermediate between the simple ortho- and meta-acids, are others containing more than a single atom of the negative radical; and that these acids may be designated by di, tri, tetra, etc., (according to the number of negative atoms) prefixed to the name of the acid, while the number of molecules of water removed from a multiple of the normal acid to form them is indicated by the same numerals prefixed to the meta.

8. That while the negative atoms in the compounds just mentioned are united by oxygen, there may be other compounds whose negative or positive atoms are united directly; thus producing a fourth class of acids and of bases.

By classifying thus the substances known as acids and bases, —and of course the salts derived from them—it is hoped that their relations to each other may be made clearer. And by giving them systematic names, their position in the series may be fixed, and a step be taken toward the establishment of a rational nomenclature.

New Haven, Oct. 10, 1867.

Art. XLIII.—*Crystallogenic and Crystallographic Contributions;* by James D. Dana. *On the Feldspar group of Minerals; supplementary to* Art. XXIX, *page* 252: *On the Chemical Formulas of the Silicates.*

1. *Chemical formulas of the Feldspars, and of some other Silicates.*

The resemblance or affiliation between the species of the Feldspar group is of the most intimate kind. There is not merely isomorphism (or close approximation in crystalline form), which, when alone, is of little value in determining relations, but also, apparently, the profoundest *isotypism.* For the approximation includes near identity in (*a*) the habitual forms; (*b*) the direction and facility of the two cleavages; (*c*) the hardness; (*d*) the color, and tendency to opalescence; (*e*) all optical characteristics; and as regards chemical composition, they agree in consisting of silica, alumina, and an alkali or alkaline earth, to the exclusion of magnesium and iron; and the oxygen ratio between the protoxyds and sesquioxyds* is for

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* The expression "oxygen ratio between the protoxyds and sesquioxyds," is equivalent, under the new system, to the ratio between the combining powers of the protoxyd or dyad and sesquioxyd or pseudotriad metals," the so-called dyad

each 1 : 3. The group, therefore, is one in nature, and chemistry must have some explanation of this unity. The following observations bear on the question of its origin.

1. The oxygen ratios for the protoxyds, sesquioxyds, and silica, in the different Feldspars, are as follows :

	$\dot{\mathrm{R}}$ $\overset{\cdots}{\overline{\mathrm{Al}}}$ $\ddot{\mathrm{Si}}$		$\dot{\mathrm{R}}$ $\overset{\cdots}{\overline{\mathrm{Al}}}$ $\ddot{\mathrm{Si}}$
Anorthite	1 : 3 : 4	Oligoclase	1 : 3 : 9
Labradorite	1 : 3 : 6	Albite	1 : 3 : 12
Andesine Hyalophane	1 : 3 : 8	Orthoclase	1 : 3 : 12

[The ratio 1 : 3 for the *basic oxyds* is expressed in the formula $\dot{\mathrm{R}}+\overset{\cdots}{\overline{\mathrm{Al}}}$, or $(\frac{1}{4}\dot{\mathrm{R}}^3+\frac{3}{4}\overset{\cdots}{\overline{\mathrm{Al}}})$; and, for the *basic metals*, in the formula $\mathrm{R}+3\beta\mathrm{Al}$, or $(\frac{1}{4}\mathrm{R}+\frac{3}{4}\beta\mathrm{Al})$; or if the perissads are distinctly indicated, in the formula $(\mathrm{R}, \mathrm{r}_2)+3\beta\mathrm{Al}$, or $(\frac{1}{4}(\mathrm{R}, \mathrm{r}_2)+\frac{3}{4}\beta\mathrm{Al})$.]

Besides the above-mentioned ratios, some analyses afford 1 : 3 : 4½, 1: 3 : 5, 1 : 3 : 5½, and other ratios between 1 : 3 : 4 and 1 : 3 : 6 ; and so also intermediate ratios between 1 : 3 : 6 and 1 : 3 : 8 ; between 1 : 3 : 8 and 1 : 3 : 9 ; and between 1 : 3 : 9 and 1 : 3 : 12. But these cases, (and also those in which there is some variation from the ratio 1 : 3,) are usually regarded as exceptional to the above as the true normal ratios ; and they have been attributed to the following causes :

(*a*) Incorrect analyses.

(*b*) Impurities : and often mixtures of different feldspars through inter-crystallization, some remarkable examples of which have been detected by microscopic and optical examinations.

(*c*) Alteration ; caused either (1) by the infiltration of ordinary waters carbonated or not —such waters filtered through powdered feldspar being known to become alkaline in a short time, and the rocks containing feldspars having been exposed to this action through long ages past ; and examples being numerous of the alteration of feldspars, ending in their kaolinization, in which both alkalies and silica are lost ; or (2) through the same process aided by mineral ingredients in the waters, resulting in the introduction of magnesia, oxyds of iron, etc., and in other changes.

As regards the views here presented, it matters not whether these intermediate ratios are irregularities produced by the above methods, or are normal ratios.

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group here including not only Ca, Mg, Fe, etc., but also K_2, Na_2, Li_2, etc., as illustrated in the classification on p. 204 of the former paper. I use beyond the expressions of the old system, as they are intelligible to all chemical readers, whether versed in the new system or not.

2. The oxygen ratio in Anorthite is that of a Unisilicate, for $1 + 3 : 4 = 1 : 1$; and the formula may be, on the old and new system:

Old $(\frac{1}{4}\dot{R}^3+\frac{3}{4}\ddot{\bar{A}}l)^2\ddot{Si}^3$ New $Si\,|\,O_4\,|\,(\frac{1}{4}R,+\frac{3}{4}\beta Al)^2$

In the other species, the oxygen ratios vary from that of Anorthite, through an increase in the proportion of silica, they being as follows:

	Bases		Silica		Bases		Silica
Labradorite	1	:	$1\frac{1}{2}$	Oligoclase	1	:	$2\frac{1}{4}$
Andesine } Hyalophane }	1	:	2	Albite	1	:	3
				Orthoclase	1	:	3

3. The silica of a Unisilicate is enough for the making of a feldspar; that is, to produce a species having that assemblage of crystalline, physical and other qualities which characterize the group. The type is therefore essentially *Unisilicate.* But while Unisilicate, it admits of increase in the proportion of silica to produce its variety of species.

4. An excess of silica above that of a Unisilicate may exist under the Unisilicate type in one of the two following conditions, and still be not an impurity.

A. It may be *basic* silica; in which case the general formula for the group would be—

Old $(\dot{R}^3,\ddot{\bar{A}}l,\ddot{Si}^{\frac{3}{2}})^2\ddot{Si}^3$ New $Si\,|\,O_4\,|\,(R, R_2), \beta Al, \gamma Si)_2$

and the special formulas for the species are:

Labradorite	$(\frac{1}{5}\dot{R}^3+\frac{3}{5}\ddot{\bar{A}}l+\frac{1}{5}\ddot{Si}^{\frac{3}{2}})^2\ddot{Si}^3$	$Si\,|\,O_4\,|\,(\frac{1}{5}(R, R_2)+\frac{3}{5}\beta Al+\frac{1}{5}\gamma Si)_2$
Andesine	$(\frac{1}{6}\dot{R}^3+\frac{3}{6}\ddot{\bar{A}}l+\frac{2}{6}\ddot{Si}^{\frac{3}{2}})^2\ddot{Si}^3$	$Si\,|\,O_4\,|\,(\frac{1}{6}(R, R_2)+\frac{3}{6}\beta Al+\frac{2}{6}\gamma Si)_2$
Oligoclase	$(\frac{2}{13}\dot{R}^3+\frac{6}{13}\ddot{\bar{A}}l+\frac{5}{13}\ddot{Si}^{\frac{3}{2}})^2\ddot{Si}^3$	$Si\,|\,O_4\,|\,(\frac{2}{13}(R, R_2)+\frac{6}{13}\beta Al+\frac{5}{13}\gamma Si)_2$
Albite	$(\frac{1}{8}\dot{N}a^3+\frac{3}{8}\ddot{\bar{A}}l+\frac{4}{8}\ddot{Si}^{\frac{3}{2}})^2\ddot{Si}^3$	$Si\,|\,O_4\,|\,(\frac{1}{8}Na_2+\frac{3}{8}\beta Al+\frac{4}{8}\gamma Si)_2$
Orthoclase	$(\frac{1}{8}\dot{K}^3+\frac{3}{8}\ddot{\bar{A}}l+\frac{4}{8}\ddot{Si}^{\frac{3}{2}})^2\ddot{Si}^3$	$Si\,|\,O_4\,|\,(\frac{1}{8}K_2+\frac{3}{8}\beta Al+\frac{4}{8}\gamma Si)_2$

R (or R, R_2) in Labradorite, Andesine and Oligoclase = Ca, Na, with occasionally some K; in Hyalophane, which has the formula of Andesine, = Ba and Na; Ba replacing the Ca of other feldspars. These formulas are partially presented on page 260.

B. It may be *accessory* silica; by which is meant, not an ingredient unessential to the species, but a true component, accessory to the fundamental type of the series.* The formulas on this view would be:—

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* This idea of the feldspars is recognized by the author in the last edition of his Mineralogy (1854) in which he heads the group as follows: "Type ratio for the oxygen of bases and silica 1 : 1, and varying from this by the addition of silica to the type"; and gives the following as the formulas:

Anorthite	$(\dot{R}+\ddot{\bar{A}}l)\ddot{Si}^{\frac{4}{3}}$	Oligoclase	$(\dot{R}+\ddot{\bar{A}}l)\ddot{Si}^3$
Andesine	$(\dot{R}+\ddot{\bar{A}}l)\ddot{Si}^{\frac{8}{3}}$	Albite	$(\dot{R}+\ddot{\bar{A}}l)\ddot{Si}^4$
Labradorite	$(\dot{R}+\ddot{\bar{A}}l)\ddot{Si}^2$	Orthoclase	$(\dot{R}+\ddot{\bar{A}}l)\ddot{Si}^4$

Anorthite	$(\frac{1}{4}\dot{R}^3+\frac{3}{4}\ddot{A}l)^2\ddot{S}i^3$	$Si\,|\,O_4\,|\,(\frac{1}{4}R+\frac{3}{4}\beta Al)_2$
Labradorite	$(\frac{1}{4}\dot{R}^3+\frac{3}{4}\ddot{A}l)^2\ddot{S}i^3+\frac{3}{2}\ddot{S}i$	$Si\,|\,O_4\,|\,(\frac{1}{4}(R,\ R_2)+\frac{3}{4}\beta Al)_2+\frac{1}{2}SiO^2$
Andesine Hyalophane	$(\frac{1}{4}\dot{R}^3+\frac{3}{4}\ddot{A}l)^2\ddot{S}i^3+3\ddot{S}i$	$Si\,|\,O_4\,|\,(\frac{1}{4}(R,\ R_2)+\frac{3}{4}\beta Al)_2+SiO^2$
Oligoclase	$(\frac{1}{4}\dot{R}^3+\frac{3}{4}\ddot{A}l)^2\ddot{S}i^3+3\frac{3}{4}\ddot{S}i$	$Si\,|\,O_4\,|\,(\frac{1}{4}(R,R_2)+\frac{3}{4}\beta Al)_2+1\frac{1}{4}SiO^2$
Orthoclase Albite	$(\frac{1}{4}\dot{R}^3+\frac{3}{4}\ddot{A}l)^2\ddot{S}^3+6\ddot{S}i$	$Si\,|\,O_4\,|\,(\frac{1}{4}R_2+\frac{3}{4}\beta Al)_2+2SiO^2$

According to either of these two methods, A or B, any other proportions of silica exceeding that of the Unisilicate may be expressed in the same manner as the above.

The last of the formulas under A, if expanded, becomes,—

Old	$(\dot{R}^3)^2\,\ddot{S}i^3 + 3\ddot{A}l^2\ddot{S}i^3 + 4\ddot{S}i^{\frac{3}{2}}\ddot{S}i^3$
New	$Si\,|\,O_4\,|\,(R_2)_2 + 3[Si\,|\,O_4\,|\,\beta Al_2] + 4[Si\,|\,O_4\,|\,\gamma Si_2]$

in which the last member consists of silica alone; and thus the formula approaches the corresponding one under B, yet with this important difference, that the silica in this member is in the former in two states, a basic and an acid.

5. *The excess of silica above the amount required for the Unisilicate increases with the increase of the alkalies, or the perissad elements, in the base.*

In Anorthite, true unisilicate feldspar, the base consists of lime without alkalies. But in the other feldspars, with higher silica, it is partly soda or potash, with lime, or in one case (Hyalophane) baryta; or it is wholly soda or potash. The ratios of non-alkaline to alkaline constituents in the bases in these species are, for the average results of analyses, as follows:

	Non-alk. : Alk.		Non-alk. : Alk.
Labradorite	2 : 1	Oligoclase	1 : 2
Hyalophane	$1\frac{1}{3}$: 1	Orthoclase	all alkali.
Andesine	1 : 1	Albite	all alkali.

Thus the above statement is fully sustained by the average results of the analyses. Looking to special analyses, it will be found that in general those Labradorites which contain less than the normal proportion of silica (and so approach Anorthite) are those which contain *most* lime in proportion to the alkali; and those which give the oxygen ratio 1 : 3 : 6·5, 1 : 3 : 7 are those which contain *least* lime relatively to the amount of alkali; and so for the ratios between 1 : 3 : 8 and 1 : 3 : 9, and others between 1 : 3 : 9 and 1 : 3 : 12. There are exceptions to this statement, as should be expected when we consider the diversity of causes (see p. 309) which may have aided in producing these intermediate ratios. But the cases in accordance are sufficient to sustain it.

It would seem, therefore, that this excess of silica is dependent in part, if not wholly, on the alkaline or perissad nature of the base.

There is a prominent exception to this view in the species Leucite, which, although *isometric* in crystallization, is regarded as of the Feldspar group, since it has a similar general constitution, with the Andesine ratio 1 : 3 : 8. For although it is thus related to Andesine, the protoxyd base is solely alkaline. Yet, as it stands apart in its isometric crystallization, it may not be as certainly in opposition as would at first seem. It may belong with Sodalite and Haüynite to an independent series in the group. Sodalite (with Haüynite) has the anorthite ratio 1 : 3 : 4, and is a soda species ; while Leucite, with 1 : 3 : 8, is a related potash species ; and if the two are in an independent series, it would appear that potash is more strongly determinative of the higher ratio of silica than soda.

6. Facts exist among other silicates that throw some light on this subject.

A. The Mica group has the following for the oxygen ratios between the bases and silica :

	Bases : Silica		Bases : Silica
1. Astrophyllite	1 : 1	5. Muscovite	1 : $1\frac{1}{4}$
2. Phlogopite	1 : 1	6. Lepidolite	1 : $1\frac{1}{2}$
3. Biotite	1 : 1	7. Cryophyllite	1 : 2
4. Lepidomelane	1 : 1		

Now the ratios of the non-alkaline to alkaline constituents of the protoxyd bases in these species, as deduced from the average results of analyses, are as follows :

	Non-alk. : Alk.		Non-alk. : Alk.
1. Astrophyllite	6 : 1	5. Muscovite	1 : 2 to 6
2. Phlogopite	6 : 1	6. Lepidolite	1 : 3 to 12
3. Biotite	3 : 1	7. Cryophyllite	almost solely alk.
4. Lepidomelane	2–1 : 1		

The non-alkaline part of the protoxyd base in the species is mostly magnesia and protoxyd of iron, with some lime ; and the alkaline, mostly potash, except in Lepidolite and Cryophyllite, which contain also lithia. The protoxyd bases are most exclusively alkaline in Cryophyllite.

The parallelism with the Feldspar group is striking ; and there may be the same reason, therefore, for the increase of the silica, and not that mentioned on page 259.

B. Again, among Unisilicates, the Meionite section of the Scapolite group illustrates the same principle. The species Meionite, Mizzonite and Marialite are closely alike in crystallographic and physical qualities, so much so that Mizzonite has generally been made a variety of Meionite ; and Marialite if it had been as long described would probably have shared the same fate. (It was first announced by vom Rath last year in the Zeitschr. d. deutschen geol. Ges., xviii, 635).

The oxygen ratios, and the ratios of the non-alkaline to the alkaline portion of the protoxyd bases, are as follows:

	$\dot{\mathrm{R}}$	$\dddot{\bar{\mathrm{R}}}$	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{R}}+\dddot{\bar{\mathrm{R}}}$	$\dddot{\mathrm{Si}}$	Non-alk.	Alk.
Meionite	1	1	2	1	1	10	1
Mizzonite	1	2	$5\frac{1}{4}$	1	$1\frac{3}{4}$	1	$1\frac{3}{4}$
Marialite	1	2	6	1	2	1	$2\frac{1}{2}$

The non-alkaline protoxyd is lime; the alkaline is soda with some potash. The excess of silica in Mizzonite and Marialite may be attributable to impurity or alteration as has been usual (and to some extent with reason) in the Scapolite division of the Scapolite group. But the crystals are glassy and show no evidence of change or mixture. They are found exclusively in volcanic or allied igneous rocks.

C. The Scapolite section of the Scapolite group affords other examples under the principle. The different compounds vary in oxygen ratio, according to the analyses, from 1 : 2 : 3·5 to 1 : 2 : 6, and from 1 : 3 : 4 to 1 : 3 : 6; and besides these there are other ratios intermediate. But Scapolite undergoes so easy alteration through the action of carbonated or alkaline waters that we have reason for doubts over many of the results of analyses.* Yet, in spite of the uncertainties from this source the principle stated comes out clearly to view. In fact it has already been remarked by Rammelsberg in his Mineral Chemie (p. 716) that "the Scapolites which are poorest in silica are richest in lime; and as the lime diminishes, the proportion of soda (or potash) increases."

Looking first at the prominent divisions, we find the following as the average ratios afforded by the best analyses.†

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* Scapolite undergoes easy alteration through carbonated waters, which make the lime a carbonate; through solutions of a potash salt, which substitute potash for the soda; and through solutions of an iron salt, which introduce oxyd of iron. Vom Rath describes mica, epidote, agalmatolite, and other pseudomorphs, after scapolite. In changing to mica, potash and iron were taken up, and soda lost; to epidote, oxyd of iron (15 to 16 p. c.) was taken and part of the silica lost; to agalmatolite, potash (7 p. c.) displaced soda, and water was taken in, and moreover, part of the lime became carbonated. Similar altered scapolites have been described by others. It is rather probable that the trace of potash found in many scapolites is always a result of change.

Couzeranite has been placed near dipyre in the table on p. 404. But it contains 5·5 p. c. of potash, and is, with hardly a doubt, an altered mineral.

Eichhorn has shown (Pogg., cv. 126) that, by subjecting chabazite to the action of a cold solution of chlorid of sodium or carbonate of soda, 6 to 8 p. c. of soda may be substituted in the mineral for an equivalent of lime; and it may be that scapolite by this or other means may have its proportion of soda increased.

† The names *Wernerite* and *Scapolite* were given to Norwegian minerals from Arendal) by d'Andrada in the same article, (in Scherer's J., iv, 35, 38, 1800). *Scapolite* is needed as a name for the whole *group*, like Feldspar, Mica, Chlorite, for corresponding groups of species, and is therefore here thus employed. *Wernerite* is applied to one of the two most prominent sections; *Ekebergite* to the other, it including the variety so-called; while Haüy's name paranthine, changed to *paranthite*, is adopted for the first of the sections. The composition of the first section was long ago the supposed composition (after Laugier's analysis) of the Arendal paranthine or scapolite.

	$\dot{R}$ $\dddot{\bar{R}}$ $\ddot{Si}$	Bases : Silica	Non-alk. : Alk.
1. Paranthite	1 : 2 : $4\frac{1}{2}$	1 : $1\frac{1}{2}$	$2\frac{1}{4}$: 1
2. Wernerite	1 : 2 : 4	1 : $1\frac{1}{3}$	4 : 1
3. Ekebergite	1 : 3 : 4	1 : 1	all non-alk.
4. Dipyre	1 : 2 : 6	1 : 2	1 : 1

As a fuller exposition of the facts, the ratios for the more satisfactory analyses, from which the above mean results have been deduced, are given in the table following. The numbering of the analyses in Rammelsberg's work is added for the convenience of reference.*

A.	$\dot{R}$ $\dddot{\bar{R}}$ $\ddot{Si}$	Bases Silica	Non-alk.: Alk
1, Pargas Storgard, Nordenskiöld	1 : 2·6 : 3·6	1 : 1·00	All non-alk.
4, Tunaberg, *trl.* Walmst.	1 : 3 : 4·2	1 : 1·05	" "
3, *a* " *trl. cryst.*, Nord.	1 : 3 : 4·3	1 : 1·06	" "
3, *b* Pargas, Ersby, *cryst.* Nord.	1 : 3·1 ; 4·4	1 : 1·07	" "
7, Pargas (Ersby?) *cryst.*, Wolff	1 : 2·9 : 4·5	1 : 1·16	17 : 1
B			
8, Pargas, Ersby, v. Rath	1 : 2·5 : 4·2	1 : 1·20	6·15 : 1
9, Arendal, *mass.*, v. Rath	1 : 1·7 : 3·4	1 : 1·24	2·65 : 1
11, " *cryst.*, v. Rath	1 : 1·8 : 3·6	1 : 1·27	5·45 : 1
16, L. Baikal, *Glaucolite*, v. Rath	1 : 2·1 : 4	1 : 1·28	3·90 : 1
15, Bolton, *pink*, Wurtz	1 : 1·8 : 3·7	1 : 1·30	2·50 : 1
13, " Thomson	1 : 2·0 : 4·0	1 : 1·33	5·70 : 1
14, Drothems, *pink*, Berg.	1 : 2·0 : 4·0	1 : 1·33	4·03 : 1
22, Bolton, *pink*, Wolff	1 : 2·2 : 4·3	1 : 1·35	3·84 : 1
17, Malsjö, *blue mass.*, v. Rath	1 : 1·7 : 4·0	1 : 1·38	5·36 : 1
18, Finland, *gnh.*, Wolff	1 : 1·9 : 4	1 : 1·38	3·98 : 1
C.			
25, Malsjö, *pink*, etc., Wolff	1 : 2·1 : 4·4	1 : 1·42	1·89 : 1
24, Pargas, *Ekebergite*, Hartw.	1 : 2 : 4·3	1 : 1·43	3·05 : 1
23, Hesselkulla, mass., Wolff	1 : 2·2 : 4·5	1 : 1·44	2·45 : 1
28, Hesselkulla, Herm.	1 : 2·5 : 5·1	1 : 1·46	3 : 1
27, Arendal, Wolff	1 : 2·1 : 4·5	1 : 1·47	2·06 : 1
Arendal, Damour	1 : 2·1 : 4·7	1 : 1·50	2·35 : 1
26, Malsjö, *white*, v. Rath	1 : 2·1 : 4·6	1 : 1·50	2·28 : 1
35, Gouverneur, *cryst.*, v. Rath	1 : 2 : 5	1 : 1·65	1·24 : 1
D.			
Couzeranite, Dufrénoy	1 : 2·3 : 5·8	1 : 1·74	1·32 : 1
Dipyre, Delesse	1 : 2·0 : 5·8	1 : 1·71	1·02 : 1
Dipyre, Damour	1 : 2·2 : 6·0	1 : 1·92	1·26 : 1
Dipyre, Pisani	1 : 2·3 : 6·5	1 : 2	0·95 : 1
Prehnitoid, Blomstrand	1 : 2 : 5·7	1 : 1·89	0·80 : 1

The four groups A, B, C, D, correspond to those above named *Paranthite*, *Wernerite*, *Ekebergite*, and *Dipyre*. Analysis No. 9, of an Arendal Scapolite diverges rather widely from the mean of the group ; but the specimen was probably an abnormal one in some way, as the results are quite unlike those obtained from Arendal specimens by Wolff and Damour (No.

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* The analyses omitted are those which are doubtful because containing carbonate of lime; those (as No. 30 by Brewer, 38 by v. Rath, etc.) which were published as analyses of *altered* scapolites; those of little hardness, thereby evincing alteration; the analyses of glaucolite by Bergemann and Givartovski, the mineral for which v. Rath has shown is of uncertain nature, and not true glaucolite.

27 and the one next following). With this exception, and that of Wurtz's (No. 15) which is not sustained in its exceptional character by Wolff's, (No. 22) of the same mineral, nor by a new determination by B. S. Burton, the concordances with the principle stated are close, considering the uncertainties of analyses, and the uncertain purity or condition of specimens.

D. Among the Bisilicates, occurs the species *Spodumene.* It is so closely like pyroxene in angles, and also in habit of crystals and physical characteristics, that it is rightly placed in the pyroxene group. It has the oxygen ratio for the protoxyds, sesquioxyds, and silica 1 : 4 : 10 ; whence 5 : 10=1 : 2 for the bases and silica, as in other Bisilicates. Its protoxyd bases are mainly alkaline, the proportion of alkaline to non-alkaline averaging 12 : 1 in the best analyses—those of Rammelsberg and Hagen (the extremes being 4 : 1 and 20 : 1), and those of Smith & Brush (which give 11 : 1 and 13 : 1). There is some iron present which is here made protoxyd as done by Rammelsberg. Descloizeaux has shown that *Petalite,* is also like pyroxene, in crystallization, and in this and other characters, approaches Spodumene. It contains, like it, silica, alumina, lithia, and soda; but the oxygen ratio is 1 : 4 : 20, the silica being doubled, as remarked by Descloizeaux. There is this other difference that the protoxyd bases are *exclusively* alkaline ; no iron is present either as protoxyd or sesquioxyd. This increase of the silica by a simple ratio is evidently parallel with the same in the Feldspar and Mica groups. And since both Spodumene and Petalite occur in granitic rocks, or those of extreme metamorphism, and therefore of like heat in origin, and as the Spodumene is often imbedded in free quartz, showing that there was no lack of silica at its formation, it would appear that the small difference of constitution as to the bases, above pointed out, determines the proportion of silica. It is quite possible that iron may have the same influence as the non-alkaline metals even if it replace alumina.*

From the above examples it seems to follow, first, that under

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* Another probable example under the principle is that of *Leucophane,* and the Chrysolite group. Chrysolite has a vertical prism of 94° 3′, with a macrodome of 76° 54′. Leucophane, also orthorhombic, has the corresponding angles 91° to 93°, and 72° 50′; there is, hence, approximate isomorphism. In both, moreover, the bases are all protoxyds; and as respects habit and physical characters, they may well be related species. Now Chrysolite is a normal Unisilicate, the oxygen ratio, for bases and silica being 1 : 1, and it contains no alkalies. While Leucophane has a large excess of silica, the oxygen ratio being $1 : 1\frac{2}{3}$ instead of 1 : 1, and, *correspondingly, it contains* 10 *to* 11 *p. c. of soda.*

Again, *Meliphane* (melinophane) appears to bear the same relation in form and constitution to phenacite, as Leucophane to Chrysolite. [The name *melinophane* is wrong and bad, the Greek signifying either *ash-* or *millet-like,* instead of *honey-like* as its author intended. It should be *melitophane* or meliphane.]

both the Unisilicate and Bisilicate type, there is some principle on which the proportion of silica may increase without changing the type; secondly, that this increase accompanies increase in the proportion of the alkalies, (or the perissad metals) and is probably more promoted by $\dot{K}$ than $\dot{Na}$; thirdly that this excess of silica occurs without a change of the type of the species from that of the Unisilicate or Bisilicate; and that the surplus silica is either accessory silica, or part of it basic.*

2. *Isomorphism of the Isometric and Clinohedral Feldspars.*

Although Leucite belongs apparently to a different series in the Feldspar group from the clinohedral (monoclinic and triclinic) species, and its trapezohedral form has seemingly very little resemblance to the oblique prisms of the other Feldspars, the monoclinic crystals of orthoclase and the triclinic of anorthite etc., are in fact nothing but distorted, or rather, *clinohedrized dodecahedrons*, variously modified by cubic, octahedral, trapezohedral and other planes.

In Orthoclase this clinohedrism consists (*a*) in giving the dodecahedron an obliquity in one direction of about 8 degrees, one of its octahedral axes, thus inclined in a vertical plane parallel to a pair of dodecahedral planes, becoming the vertical axis; and (*b*) slightly shortening this axis; and for the triclinic forms, it is nearly the same, excepting that the obliquity extends to the vertical plane referred to, and consequently to the planes about it.

The annexed figure represents a common form of Orthoclase, copied from Naumann's crystallography. The lettering corresponds to the following in Naumann, and Brooke and Miller:

	O	*I*	*i-i*	*i-3*ˋ	*⅔-i*	1-*i*	2-*i*	1	2-*i*]
Naumann	0P	∞P	[∞P∞]	[∞P3]	⅔P∞	P∞	2P∞	P	[P∞]
	P	*T, l*	*M*	*z*	*q*	*x*	*y*	*o*	*n*
Brooke & Miller	001	110	010	130	203	101	201	111	021
	c	*m*	*b*	*z*	*q*	*x*	*y*	*o*	*n*

The prismatic angle of the crystals is 118° 48′ or near 120°; and the same angle in Albite is 120° 47′; in Oligoclase 120° 42′; in Labradorite 121° 37′; in Anorthite 120° 30′.

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* *Errata.*—In these articles, this volume, p. 93, 14 l. fr. foot, for $\frac{1}{5}$ read $\frac{2}{5}$; 10 l. and 13 l. fr. foot, for δ read ε, and for ε read δ. Page 253, for RO^5 read R^2O^5; for $5R_{\frac{1}{5}}O$ read $5R_{\frac{2}{5}}O$; for $R_{\frac{1}{2}}$, $R_{\frac{1}{3}}$, $R_{\frac{1}{5}}$, read $R_{\frac{1}{2}}$, $R_{\frac{2}{5}}$, $R_{\frac{1}{3}}$; for δ read ε, and for ε read δ. Page 255, 9 l. fr. foot, p. 258, 8 l. fr. top, p. 259, 2 l. fr. top, for δ read ε.

In order to appreciate the following comparisons, the reader should have before him a dodecahedral crystal, (of garnet, for example,) or a model of the form, placed with a trihedral angle at top, and with one face of the trihedral pyramid sloping to the left; in which position it is a 6-sided prism with trihedral summits, with its planes parallel to those of the figure.

The prismatic angle of the feldspars, as in many other minerals, is very closely the angle of the dodecahedron (120°); and the four planes *I* enclosing it correspond therefore to four of the vertical faces of this dodecahedron; while the two planes *i-ĭ* which make angles with *I* of 120° 26′, are the other two.

The basal plane *O* is another dodecahedric plane; for *O* : *I* =122° 16′; and O : *i-ĭ*=90°, the exact dodecahedral angle. This makes *eight* out of the twelve.

The four planes 1, are also dodecahedric. This might be inferred from their position as referred to a model dodecahedron. It is also apparent in the angles which the planes make with one another and with the planes just shown to be dodecahedric, namely *O*, *I*, and *i-ĭ*; for 1 : 1=126° 14′, *O* : 1=124° 42′, *i-ĭ* : 1=116° 53′, the mean of which is nearly 120°. The divergence from 120° is due to the 8° of obliquity which the dodecahedral form has in orthoclase. Thus *all the twelve faces of the dodecahedron* exist on the crystal of orthoclase in the figure here presented. They are lettered **D**.

Moreover the *cleavage* in orthoclase according to this result is dodecahedric, it being parallel to *O* and *i-ĭ*, which planes are at right angles both in orthoclase and the dodecahedron.

The plane *i-3'* replaces an edge between *I* (**D**) and *i-ĭ* (**D**); making the angle =*i-ĭ* : *i-3'*=150° 35′. The planes *i-3'* are therefore those of the *trapezohedron* 2-2, which truncate the edges of the dodecahedron, and make with the dodecahedral planes the angle 150°; they are therefore lettered **T**. The plane 1-*i* truncates the edge between 1 and 1, other planes **D** (dodecahedric), and therefore this also is a trapezohedric plane, and is lettered **T**; it makes with each plane 1 the angle 153° 7′ (which is near 150°); and with O (**D**), over the plane $\frac{2}{3}$-*i*(**O**), the angle 129° 41′, the corresponding isometric angle being 125° 16′. The crystal therefore contains six faces of the trapezohedron 2-2.

Again 2-*ĭ* are faces of the cube (or hexahedron), and are therefore lettered **H**; the angle *O* (**D**) : 2-*ĭ*=135° 3′ while the corresponding isometric angle is 135° Referred to the model dodecahedron, it truncates the tetrahedral solid angles. Again 2-*i* has the position of a plane truncating another tetrahedral solid angle of the dodecahedron, and is also a face of a cube, and is lettered **H**. The angle *I* (**D**) : 2-*i*=134° 19′ or very nearly

135° the angle between a face of a cube and a plane truncating its edges.

The plane ⅔-*i*, at the top of the figure, the only remaining one, is a face of the *octahedron*,—a plane which on the dodecahedron truncates its trihedral solid angles,—and it is therefore lettered **O**. The angle *I* (**D**) : ⅔-*i*=145° 47′, while the angle between a dodecahedral and octahedral plane, is 144° 44′. The angle 2-*i* (**H**) : ⅔-*i*=124° 51′, while the angle between a cubic and octahedral plane is 125° 16′. That the plane is octahedric is further apparent from the parallel intersections of ⅔-*i*, 2-*ì*, *i*-3ʽ, and of *O*, ⅔-*i*, 2-*i*; for (1) a cubic face makes parallel intersections between an octahedral on one side (the trapezohedral on that side being absent) and a trapezohedral on the other; and (2) an octahedral face makes parallel intersections with a cubic on one side and a dodecahedral on the other.

The form of orthoclase is therefore strictly a clinohedrized dodecahedron. The faces present in the crystal here considered, are

The *dodecahedric*, *I*, *I*, *i*-*ì*, *O*, 1, 1, with their opposites, or *the whole twelve.*

The *trapezohedric*, 1-*i*, *i*-3ʽ, *i*-3ʽ, with their opposites, or *six* in all.

The *octahedric*, ⅔-*i*, with its opposite, or *two.*

The *cubic*, 2-*ì*, 2-*ì*, 2-*i*, with their opposites, or *the whole six.* The angles of this oblique or clinohedrized cube are 2-*ì* : 2-*ì* over *O* =90° 6′, 2-*ì* : 2-*i*=96° 48′.

The true or normal apex of the orthoclase dodecahedron is that part of the crystal occupied by the octahedric plane ⅔-*i*; and the true obliquity of the crystal (or angle C,) instead of being 63° 53′ and 116° 7′ (or the angle *O* : *i*-*i*) would be the angle ⅔-*i* : *i*-*i*, which equals 81° 54′ and 98° 06′. Hence 8° 6′ is the extent to which the octahedron has been clinohedrized in its conversion into the form of orthoclase.

For the triclinic feldspars, the only peculiarity is that already mentioned,—the fact of lateral obliquity of the principle section, so that the two cleavage planes O, *i*-*ì* (dodecahedric planes on opposite sides of a tetrahedral solid angle) make with one another an angle of 93° 15′ to 94° 15′ instead of 90°. The form of the crystals are so similar to those of orthoclase, with this exception, that special explanations are unnecessary.

G. Rose, in a recent article on Albite (Pogg., cxxv, p. 457), observes (p. 466), that it is a remarkable fact that the planes 2-*ĭ* situated either side of *O*, between it and *i*-*ĭ*, (planes *e* and *n* of Rose,) make with one another in albite very nearly a right angle, 90° 35′ according to Neumann, and 90° 4′ according to DesCloizeaux's measurements. It is not so surprising when it is understood that the two planes 2-ĭ in albite are *cubic* faces.

In addition to the above dodecahedric characteristics of the crystals of the Feldspar group, it may be added that the twins are twinned parallel either to dodecahedric or cubic faces. The most common in orthoclase are those parallel to *i*-ĭ, dodecahedric; others are twinned parallel to *O*, also dodecahedric; others parallel to 2-ĭ, or a cubic face. And there are no other directions of twinning among the *triclinic* feldspars.

In another number of this Journal I propose to consider further the isometric relations of the various systems of crystallization, a subject partly elucidated in the last edition of my Mineralogy (1854, vol. i, pp. 196–204), and also in this Journal for the same year, vols. xvii, and xviii.

ART. XLV.—*On certain points in the theory of Atomicities;* by WOLCOTT GIBBS, M.D., Rumford Professor in Harvard University.

IN the application of the theory of atomicities to the explanation of the formation and structure of compound bodies two distinct views are held by chemists. While Kekulé and his followers maintain that the primary or essential atomicity of each element is invariable, Wurtz, Frankland and others admit that an element may have more than one degree of saturating power, Wurtz in particular assigning no specific maximum or limit in any case. The chemists of both these schools distinguish between atomic and molecular combinations, differing only as to what combinations are to be regarded as molecular. Thus according to Kekulé pentachlorid of phosphorus is a molecular compound, $P^{III}Cl_3+Cl_2$, while upon the other view it is atomic and has the formula $P^{V}Cl_5$. All chemists appear to admit that water of crystallization is in molecular and not in atomic combination.

To this view it may be reasonably objected that it creates two distinct species of chemical affinity, for if phosphorus in the terchlorid is saturated and its three units of affinity satisfied, a new force must be called in to bind the two additional atoms of chlorine which are to form the pentachlorid, and if chlorid of sodium be a saturated atomic combination, by what force does it unite with two atoms of water to form $NaCl+2H_2\Theta$? The line which this theory draws between molecular and atomic combinations is, moreover, a purely arbitrary one, as is clearly seen in the case of the chlorids of phosphorus cited above. In the present paper I shall endeavor to show that the assumption of a particular class of molecular compounds is unnecessary, and that all compounds may be regarded as essentially atomic. I adopt the following postulates no one of which is new.

1. The elements may be divided into two classes; those whose primary or inherent atomicities are represented by odd, and those whose atomicities are represented by even numbers.

2. The atomicities are variable and no maximum or limit can be assigned in any case. Any element of the first class may therefore be 1, 3, 5, 7, &c., atomic, and any element of the second class 2, 4, 6, 8, &c., atomic.

3. In the combinations of an element with itself or with another element a certain number of units of atomicity disappear. The atomicity of the resulting compound will be termed *secondary*.

For the sake of convenience I shall give the name of *determinant* to the dominant element in any compound, the other elements being termed *sub-determinants* or *subjects*, while the compound itself is termed the *resultant*. Thus in ammonia, $N \begin{cases} H \\ H, \\ H \end{cases}$ nitrogen is the determinant, and hydrogen the subject, while in nitrid of copper, $N_2 \begin{cases} \text{Ȼu} \\ \text{Ȼu}, \\ \text{Ȼu} \end{cases}$ copper is the sub-determinant. In borid of nitrogen, $B^{III}N^{III}$, either element may be taken as the determinant. According to this view ammonia may be regarded as the product of a single action, that, namely, of nitrogen upon hydrogen, while in nitrid of copper there are two actions, the duplication of the atom of nitrogen being due to the diatomic character of the copper.

If now we consider first the case of water, ΘH_2, it is easy to see that if oxygen be regarded as tetratomic or at least as having an even atomicity higher than 2, water will itself be weakly diatomic, whatever may be the number of atoms of this body in a given compound. For in $\Theta^{iv}H_2$ it is clear that only two units of affinity are saturated. Morever, in any number of atoms of water two units will vanish for every atom with the exception of the first and last, in each of which one unit only will disappear. Graphically this may be represented as follows:

—○—○—○—○—○—○—

From this it appears that the atomicity of the water of crystallization in a salt may always be considered as 2, whatever be the number of atoms. In like manner it is easily seen that ammonia, $N^{v}H_3$, is diatomic, and that any number of associated atoms of ammonia will still, as a whole, represent only a single diatomic atom.

With these preliminaries I shall consider in order a few cases of what is termed molecular union.

Since sodium may be regarded as feebly triatomic it follows that in chlorid of sodium, $\mathrm{Na^{III}Cl}$, there are still two units of affinity unsaturated, the intensity of the affinity being very small. Hence the salt, $\mathrm{Na^{III}Cl+(2\Theta H_2)''}$, in which the sodium may be regarded as saturated, exists only at low temperatures. In sodic sulphate we may for convenience take sulphur as the determinant, in which case the salt will have the formula, $\mathrm{S^{IV}}\left\{\begin{array}{l}\Theta_2\\ (\mathrm{Na}\Theta)_2\end{array}\right.$ considered as anhydrous. But the crystallized salt contains ten atoms of water and may be written $\mathrm{S^{VI}}\left\{\begin{array}{l}\Theta_2\\ (\mathrm{Na}\Theta)'_2\\ (\Theta\mathrm{H}_2)''_{10}\end{array}\right.$ to exhibit the manner in which the water of crystallization completes the saturation of the hexatomic sulphur.

Trisodic ortho-phosphate contains twelve atoms of water, and if we take phosphorus as the determinant may be written

$$\mathrm{P^{VII}}\left\{\begin{array}{l}\Theta''\\ (\mathrm{Na}\Theta)_3\\ (\Theta\mathrm{H})''_{12}\end{array}\right.$$

phosphorus being heptatomic.

These formulas will suffice to exhibit the application of the theory to cases in which water of crystallization is present. To avoid complication in expression it would perhaps be more convenient to indicate the subordinate atomicity by Roman numerals placed beneath the symbol of the determinant and to connect the water of crystallization in the usual manner by the sign +. Thus sodic sulphate may be written

$$\overset{\mathrm{iv}}{\underset{\mathrm{II}}{\mathrm{S}}}\left\{\begin{array}{l}\Theta_2\\ (\mathrm{Na}\Theta)_2\end{array}\right. +10\mathrm{aq}$$

which exhibits at once both degrees of atomicity.

The views above explained enable us to formulate as atomic compounds the very numerous class of so-called double haloid salts usually regarded as molecular. Thus acid fluorid of potassium, KF+HF, becomes

$$\left.\begin{array}{c}\mathrm{K^{III}F_2}\\ \mathrm{H}\end{array}\right\}\text{ or }\mathrm{K\,(H^{III}F_2)}$$

which may be compared directly with hydrate of potash

$$\left.\begin{array}{c}\mathrm{K^{III}\Theta^{II}}\\ \mathrm{H}\end{array}\right\}\text{ or }\mathrm{K(H^{III}\Theta)}.$$

The so-called double fluorids of tin, zirconium and silicon may readily be reduced to the following types in which in each case the tetratomic element is taken as the determinant.

$\mathrm{SnF_4+2KF}$ $\qquad$ $\mathrm{Sn}\left\{\begin{array}{l}\mathrm{F_2}\\ (\mathrm{KF_2})_2\end{array}\right.$

$$\mathrm{SnF_4+3KF+HF}, \qquad \mathrm{Sn}\left\{\begin{matrix}3(\mathrm{KF_2})\\(\mathrm{HF_2})\end{matrix}\right.,$$

$$\mathrm{ZrF_4+3CuF}, \qquad \begin{matrix}{}'\mathrm{Zr}^{\mathrm{iv}}\\{}'\mathrm{Zr}^{\mathrm{iv}}\end{matrix}\left\{\ 3(\text{Ȼ}\mathrm{uF_4})''\right.$$

$$\mathrm{SnF_4+4NH_4F} \qquad \mathrm{Sn}\{\ 4(\mathrm{NH_4F_2})$$

$$\mathrm{SnF_4+BaF_2} \qquad \mathrm{Sn}\left\{\begin{matrix}\mathrm{F_2}\\(\mathrm{Ba^{vi}F_4})''\end{matrix}\right.$$

$$\mathrm{2ZrF_4+2KF+NiF_2}' \qquad \begin{matrix}{}'\mathrm{Z^{iv}r}\\\mathrm{Z^{iv}r}\end{matrix}\left\{(\mathrm{KF_2})''_2(\mathrm{NiF_4})''\right.$$

$$\mathrm{ZrF_4+2NiF_2} \qquad \mathrm{Zr}\{\ 2(\mathrm{NiF_4})''$$

$$\mathrm{2ZrF_4+5NaF}\ \begin{matrix}{}''\mathrm{Zr^{vi}}\\{}''\mathrm{Zr^{vi}}\end{matrix}\left\{\ (\mathrm{NaF_2})_5(\mathrm{F})_3\right. \qquad \mathrm{ZrF_4+4KF} \quad \mathrm{Zr}\left\{(\mathrm{KF_2})_4\right.$$

$$\mathrm{ZrF_4+3KF} \quad \mathrm{Zr}\left\{\begin{matrix}(\mathrm{KF_2})_3\\\mathrm{F}\end{matrix}\right. \qquad \mathrm{SiF_4+2KF} \quad \mathrm{Sn}\left\{\begin{matrix}(\mathrm{KF_2})_2\\\mathrm{F_2}\end{matrix}\right.$$

$$\mathrm{ZrF_4+KF} \quad \mathrm{Zr}\left\{\begin{matrix}(\mathrm{KF_2})\\\mathrm{F_3}\end{matrix}\right.$$

The compounds of the fluorids of tantalum, niobium, arsenic and antimony with other fluorids may be reduced to the following types, taking the pentatomic element as the determinant, and as before omitting water of crystallization for the sake of simplicity.*

$$\mathrm{TaF_5+2KF} \quad \mathrm{Ta}\left\{\begin{matrix}\mathrm{F_3}\\(\mathrm{KF_2})_2\end{matrix}\right. \quad \mathrm{Nb\Theta_2F_3+2KF} \quad \mathrm{Nb}\left\{\begin{matrix}\Theta\\\mathrm{F}\\(\mathrm{KF_2})_2\end{matrix}\right.$$

$$\mathrm{NbF_5+2KF} \quad \mathrm{Nb}\left\{\begin{matrix}\mathrm{F_3}\\(\mathrm{KF_2})_2\end{matrix}\right. \quad \mathrm{Nb\Theta_4F_3+3KF} \quad \mathrm{Nb}\left\{\begin{matrix}\Theta\\(\mathrm{KF_2})_3\end{matrix}\right.$$

$$\mathrm{Nb\Theta F_3+3KF+HF} \quad \mathrm{Nb}\left\{\begin{matrix}\mathrm{F}\\(\mathrm{H\Theta})\\(\mathrm{KF_2})_3\end{matrix}\right.$$

$$\mathrm{3Nb\Theta F_3+5KF} \qquad \begin{matrix}{}''\mathrm{Nb^{vii}}\\{}''\mathrm{Nb^{vii}}\\{}''\mathrm{Nb^{vii}}\end{matrix}\left\{\ \Theta_3(\mathrm{KF_2})_5\mathrm{F_4}\right.$$

$$\mathrm{3Nb\Theta F_3+4KF} \qquad \begin{matrix}{}''\mathrm{Nb^{vii}}\\{}''\mathrm{Nb^{vii}}\\{}''\mathrm{Nb^{vii}}\end{matrix}\left\{\ \Theta_3(\mathrm{KF_2})_4\mathrm{F_5}\right.$$

$$\mathrm{Nb\Theta F_3+ZnF_2} \qquad \mathrm{Nb}\left\{\begin{matrix}\Theta\\\mathrm{F}\\(\mathrm{ZnF_4})''\end{matrix}\right.$$

$$\mathrm{SbF_5, KF}, \ \mathrm{Sb}\left\{\begin{matrix}\mathrm{F_4}\\(\mathrm{KF_2})\end{matrix}\right., \ \mathrm{SbF_5, 2KF}, \ \mathrm{Sb}\left\{\begin{matrix}\mathrm{F_3}\\(\mathrm{KF_2})_2\end{matrix}\right.$$

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* It must be remarked that in the comparative formulas given above the symbols of the elements in the expressions on the left hand usually, when not barred, signify the old equivalent, while in those on the right they signify atoms. The want of type for all the barred letters is the occasion of this confusion which I hope will be excused.

$$Sb\Theta F_3,\ NaF, Sb\left\{\begin{matrix}\Theta\\ (NaF_2)\\ F_2\end{matrix}\right.,\ As_2\Theta F_8,\ 4KF,\ \begin{matrix}{}''As^{vii}\\ {}''As^{vii}\end{matrix}\left\{(KF_2)_4\Theta F_4\right.$$

Finally the two remarkable salts discovered by Brieglеb and which are represented empirically by the formulas

$$P\Theta_4Na_3+NaF+12aq \text{ and } As\Theta_4Na_3+NaF+12aq$$

may at once be reduced to the normal pentatomic type as follows:

$$P^{v}\left\{\begin{matrix}(Na\Theta)_4\\ F\end{matrix}\right.+12aq, \text{ and } A^{v}s\left\{\begin{matrix}(Na\Theta)_4\\ F\end{matrix}\right.+12aq.$$

It is to be remarked that in two of the above formulas, niobium, and in one arsenic, is represented as heptatomic. In these cases each atom of niobium, or of arsenic, loses two units of affinity in combining with an associate atom of the same elements. The notation employed in this and similar cases is that of Frankland.

From the double fluorids so-called, I pass to the consideration of the double chlorids, which, as is well known, are very numerous.

A glance at the following formulas will show the application of the principles which I have laid down to this class of compounds.

$HgCl_2+MnCl_2$	$Hg^{ii}\left\{(Mn^{vi}Cl_4)''\right.$
$2HgCl_2+BaCl_2$	$\begin{matrix}{}''Hg^{iv}\\ {}''Hg^{iv}\end{matrix}\left\{Ba^{vi}Cl_4)''(Cl)_2\right.$
$5HgCl_2+CaCl_2$	$\begin{matrix}{}''Hg^{iv}\\ {}''Hg^{iv}\\ {}''Hg^{iv}\\ {}''Hg^{iv}\\ {}''Hg^{iv}\end{matrix}\left\{(\text{Є}aCl_4)''Cl_8\right.$
$2KCl+HgCl_2$	$Hg^{ii}(KCl_2)_2$
$KCl+HgCl_2$	$Hg^{ii}(KCl_2)Cl$
$KCl+2HgCl_2$	$\begin{matrix}{}''Hg^{iv}\\ {}''Hg^{iv}\end{matrix}\left\{\begin{matrix}(KCl_2)\\ Cl_3\end{matrix}\right.$
$MgCl_2+3HgCl_2$	$\begin{matrix}{}''Hg^{iv}\\ {}''Hg^{iv}\\ {}''Hg^{iv}\end{matrix}\left\{(MgCl_4)''Cl_4\right.$
$PtCl_4+2KCl$	$Pt\left\{\begin{matrix}Cl_2\\ (KCl_2)_2\end{matrix}\right.$
$PtCl_4+BaCl_2$	$Pt\left\{\begin{matrix}Cl_2\\ (BaCl_4)''\end{matrix}\right.$
PtI_4+2HI	$Pt\left\{\begin{matrix}I_2\\ (HI_2)_2\end{matrix}\right.$
Ir_2Cl_6+4KCl	$\begin{matrix}{}'Ir^{iv}\\ {}'Ir^{iv}\end{matrix}\left\{(KCl_2)_4Cl_2\right.$

$$\mathrm{Ir'_2Cl_6+6KCl} \qquad \left.\begin{array}{r}{}'\mathrm{I}^{\mathrm{iv}}{}_2\\ {}'\mathrm{I}^{\mathrm{iv}}{}_2\end{array}\right\{ (\mathrm{KCl_2})_6$$

$$\mathrm{U_2\Theta_2Cl_2+2KCl} \qquad \left.\begin{array}{r}{}''\mathrm{U}^{\mathrm{iv}}\\ {}''\mathrm{U}^{\mathrm{iv}}\end{array}\right\{ \begin{array}{l}\Theta_2\\ (\mathrm{KCl_2})_2\end{array}$$

$$\mathrm{AuCl_3+KCl} \qquad \mathrm{Au}^{\mathrm{iv}}\left\{\begin{array}{l}\mathrm{Cl_2}\\ (\mathrm{KCl_2})\end{array}\right.$$

$$\mathrm{2AuCl_3+BaCl_2} \qquad \left.\begin{array}{r}{}''\mathrm{Au}^{\mathrm{v}}\\ {}''\mathrm{Au}^{\mathrm{v}}\end{array}\right\{ \begin{array}{l}\mathrm{Cl_4}\\ (\mathrm{BaCl_4})''\end{array}$$

$$\mathrm{W\Theta_4K_2+WF_8K_2} \qquad \mathrm{W}^{\mathrm{vi}}\left\{\begin{array}{l}\Theta_2\\ (\mathrm{KF_2})_2\end{array}\right. \quad \text{like} \quad \mathrm{W}^{\mathrm{vi}}\left\{\begin{array}{l}\Theta_2\\ (\mathrm{K\Theta})_2\end{array}\right.$$

$$\mathrm{W\Theta_2F_3K} \qquad \mathrm{W}^{\mathrm{vi}}\left\{\begin{array}{l}\Theta_2\\ \mathrm{F}\\ (\mathrm{KF_2})\end{array}\right.$$

$$\mathrm{W\Theta_2}\bar{\mathrm{C}}\mathrm{uF_4} \qquad \mathrm{W}^{\mathrm{vi}}\left\{\begin{array}{l}(\bar{\mathrm{C}}\mathrm{u}\Theta_2)''\\ \mathrm{F_4}\end{array}\right.$$

$$\mathrm{W\Theta_2}\bar{\mathrm{C}}\mathrm{uF_4+NH_4F} \qquad \mathrm{W}^{\mathrm{vi}}\left\{\begin{array}{l}(\bar{\mathrm{C}}\mathrm{u}\Theta_2)''\\ (\mathrm{NH_4.F_2})\\ \mathrm{F_3}\end{array}\right.$$

The principle of variable atomicity enables us also to formulate a great variety of other compounds which have hitherto been considered as molecular. As the application is sufficiently evident after what has been said, I shall content myself with a few examples only.

All combinations of metallic chlorids, &c., with ammonia may be formulated atomistically if it be admitted that *n* atoms of ammonia are as a whole simply diatomic. Thus we have

$$\mathrm{TiCl_4+4NH_3} \qquad \mathrm{Ti}^{\mathrm{vi}}\left\{\begin{array}{l}\mathrm{Cl_4}\\ (\mathrm{4NH_3})''\end{array}\right.$$

Chlor. of Roseocobalt, $\bar{\mathrm{C}}\mathrm{o_2Cl_6+10NH_3}$ $\quad \left.\begin{array}{r}{}''\bar{\mathrm{C}}\mathrm{o}^{\mathrm{vi}}\\ {}''\bar{\mathrm{C}}\mathrm{o}^{\mathrm{vi}}\end{array}\right\{ \mathrm{Cl_6(10NH_3)''}$

Chlor. of Luteocobalt, $\bar{\mathrm{C}}\mathrm{o_2Cl_6+12NH_3}$ $\quad \left.\begin{array}{r}{}''\bar{\mathrm{C}}\mathrm{o}^{\mathrm{vi}}\\ {}''\bar{\mathrm{C}}\mathrm{o}^{\mathrm{vi}}\end{array}\right\{ \mathrm{Cl_6(12NH_3)''}$

{Chlor. of Xanthocob't, $\bar{\mathrm{C}}\mathrm{o_2\Theta Cl_2+N_2\Theta_3+10NH_3}$ $\quad \left.\begin{array}{r}{}''\bar{\mathrm{C}}\mathrm{o}^{\mathrm{vi}}\\ {}''\bar{\mathrm{C}}\mathrm{o}^{\mathrm{vi}}\end{array}\right\{ \mathrm{\Theta_2Cl_2(N_2\Theta_3.10NH_3)''}$

{Sulph. of Roseocobalt, $\bar{\mathrm{C}}\mathrm{o_2}(\bar{\mathrm{S}}\Theta_4)_3\mathrm{+10NH_3}$ $\quad \left.\begin{array}{r}{}''\bar{\mathrm{C}}\mathrm{o}^{\mathrm{vi}}\\ {}''\bar{\mathrm{C}}\mathrm{o}^{\mathrm{vi}}\end{array}\right\{ (\bar{\mathrm{S}}\Theta_4)''{}_3\mathrm{(10NH_3)''}$

{Sulph. of Luteocobalt, $\bar{\mathrm{C}}\mathrm{o_2}(\bar{\mathrm{S}}\Theta_4)_3\mathrm{+12NH_3}$ $\quad \left.\begin{array}{r}{}''\bar{\mathrm{C}}\mathrm{o}^{\mathrm{vi}}\\ {}''\bar{\mathrm{C}}\mathrm{o}^{\mathrm{vi}}\end{array}\right\{ (\bar{\mathrm{S}}\Theta_4)''{}_3\mathrm{(12NH_3)''}$

{Sulph. of Xanthocob't, $\bar{\mathrm{C}}\mathrm{o_2}(\bar{\mathrm{S}}\Theta_4)_2\mathrm{+N_2\Theta_3+10NH_3}$ $\quad \left.\begin{array}{r}{}''\bar{\mathrm{C}}\mathrm{o}^{\mathrm{vi}}\\ {}''\bar{\mathrm{C}}\mathrm{o}^{\mathrm{vi}}\end{array}\right\{ \begin{array}{l}\Theta''(\bar{\mathrm{S}}\Theta_4)''{}_3\\ \mathrm{(N_2\Theta_3.10NH_3)''}\end{array}$

Gros' base, $\mathrm{PtCl_2N_4H_{12}\Theta}$ $\quad \mathrm{Pt}^{\mathrm{vi}}\{\ \mathrm{Cl_2(4NH_3)''\Theta''}$

Reiset's base No. 1, $\mathrm{PtN_4H_{12}\Theta}$ $\quad \mathrm{Pt}^{\mathrm{iv}}\{\ \mathrm{(4NH_3)''\Theta''}$

" " No. 2, $\mathrm{PtN_2H_6\Theta}$ $\quad \mathrm{Pt}^{\mathrm{iv}}\{\ \mathrm{(2NH_3)''\Theta''}$

Raewsky's base No. 1, $Pt_2Cl_2\Theta_3H_{24}\Theta_2N_8$ $\left.\begin{matrix}'Pt^{iv}\\ 'Pt^{iv}\end{matrix}\right\}Cl_2\Theta_5(8NH_3)''$

" " No. 2, $Pt_2Cl_4\Theta_4H_{24}\Theta_2N_8$ $\left.\begin{matrix}''Pt^{vi}\\ ''Pt^{vi}\end{matrix}\right\}Cl_4\Theta_6(8NH_3)''$

If it be objected to the assumption that potassium, sodium, &c., are triatomic in certain combinations, that these elements have not yet been observed to form compounds with chlorine and other usually monatomic elements of the form $K\left\{\begin{matrix}Cl\\ Cl\\ Cl\end{matrix}\right.$, I reply first that thallium, which unquestionably belongs to the alkaline group, is distinctly triatomic in $TlCl_3$, and secondly that if chlorine itself be sometimes triatomic, the compound KCl may be represented as $K^{III}Cl^{III}$ as well as $K^{I}Cl^{I}$, each element being saturated upon either view. With respect to the elements belonging to the nitrogen group I will simply call attention to the fact that nitrogen is heptatomic in the hyperiodids of certain complex ammoniums and enneatomic in others. Thus we have

$$N\left\{\begin{matrix}(\text{Є}H_3)_4\\ I_3\end{matrix}\right., \quad \text{and} \quad N\left\{\begin{matrix}(\text{Є}H_3)_4\\ I_5\end{matrix}\right.,$$

so that nitrogen furnishes the most complete series of atomicities, being 1, 3, 5, 7 and 9-atomic.

It is easily seen that there is a marked difference between the elements both of odd and of even atomicities as regards the maximum intensity of combining power. Thus potassium, sodium, hydrogen, chlorine and some other elements have their maximum of affinity with an atomicity of unity, the affinity being very much less for an atomicity of three and insensible for higher atomicities. Nitrogen, phosphorus, boron and several others have an insensible affinity for an atomicity of unity; the intensity of their affinity becomes a maximum when they are triatomic, diminishes materially when they become pentatomic, and becomes nearly insensible when they are heptatomic. Finally, tantalum and niobium have their maximum intensity of combining power with an atomicity of five. Precisely analogous differences occur with the elements of even atomicity. We are not yet in a position to determine whether the combination of two or more atoms of water, of ammonia, or in general of any compound, is accompanied by a gain or loss of combining power. In other words we do not know whether $(n\Theta H_2)''$, for example, has more or less potential chemical energy than $(\Theta H_2)''$. But we have, as I think, a right to infer that the number of atoms of water of crystallization in a salt is determined by the residual unsaturated units of affinity in the determinants of the salt itself, and will always be, for given circumstances, such as will saturate those determinants most nearly. Thus it is conceivable that at one temperature a salt may crystallize with two, and at another with four atoms of water, the whole quantity of water being in each case diatomic, but exerting different intensities of affinity. The same principle will apply to ammonia and other compounds.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On a new class of homologues of cyanhydric acid.*—Prof. A. W. Hofmann has communicated to the Academy of Sciences a very interesting and important memoir on a class of cyanids isomeric with the so-called nitriles but possessing very different properties. Cyanhydric acid, as is well known, under the influence of water takes up the elements of that body and forms ammonia and formic acid, the reaction being represented by the equation

$$\text{Є}MH+2H_2\Theta=\text{Є}H_2\Theta+NH_3.$$

Under the same circumstances the cyanids of the alcohol-radicals may yield one or the other of two different reactions. Thus in the case of cyanid of methyl we might have

$$1.\quad \underset{\text{Cyanid of methyl.}}{\text{Є}N\text{Є}H_3}+\underset{\text{Water.}}{2H_2\Theta}=\underset{\text{Acetic acid.}}{\text{Є}_2H_4\Theta_2}+\underset{\text{Ammonia.}}{NH_3}$$

or

$$2.\quad \underset{\text{Cyanid of methyl.}}{\text{Є}N\text{Є}H_3}+\underset{\text{Water.}}{2H_2\Theta}=\underset{\text{Formic acid.}}{\text{Є}H_2\Theta_2}+\underset{\text{Methylamine.}}{NH_2\text{Є}H_3}$$

Examples of the first mode of reaction have long been known, but bodies exhibiting the second mode of reaction have not hitherto been observed. When chloroform and ammonia are heated together under pressure chlorhydric and cyanhydric acids are formed the reaction being expressed by the equation

$$\text{Є}HCl_3+NH_3=3HCl+\text{Є}NH.$$

Dr. Hofmann showed that this reaction takes place easily at a boiling heat when caustic potash is added to the alcoholic solution of ammonia and chloroform. On repeating this experiment with aniline instead of ammonia, Dr. Hofmann found that an oily liquid is found which passes over, on distilling the mixture, mixed with aniline. The aniline is removed by oxalic acid and the oil dried by caustic potash and distilled. It is a liquid which is green by transmitted and blue by reflected light. Its formula is Є_7H_5N, and it is therefore isomeric with benzonitrile. The formation of this body is represented by the equation

$$\text{Є}_6H_7N+\text{Є}HCl_3=\text{Є}_7H_5N+3HCl.$$

Dr. Hofmann calls this substance cyanid of phenyl; its physical properties are entirely different from those of benzonitrile; it unites directly with metallic cyanids, even with cyanid of silver, and by taking up water forms aniline and formic acid—

$$\text{Є}_7H_5\,.\,N+2H_2\Theta=\text{Є}_6H_5H_2N+\text{Є}H_2\Theta_2.$$

It is remarkable that while the nitrids are easily decomposed by boiling alkaline solutions cyanid of phenyl is scarcely altered by these but is hydrated by the action of dilute acids.

When benzonitrile is converted into benzoic acid benzamid is formed as an intermediate product

$$\text{Є}_7\mathrm{H}_5\mathrm{N}+\mathrm{H}_2\Theta=\underset{\text{Benzamid.}}{\text{Є}_7\mathrm{H}_7\mathrm{N}\Theta}.$$

When cyanid of phenyl forms aniline and formic acid phenyl-formamid is formed as an intermediate product

$$\text{Є}_7\mathrm{H}_5\mathrm{N}+\mathrm{H}_2\Theta=\underset{\text{Phenyl-formamid.}}{\text{Є}_7\mathrm{H}_7\mathrm{N}\Theta}$$

But in this case another intermediate product is formed which is methenyl-diphenyl-diamine, formerly discovered by Hofmann. Ethylamine, amylamine and toluidine yield new cyanids by a similar reaction. The difference between the nitriles and the new cyanids may be explained by referring them to different types. Thus in the case of the two cyanids of methyl we have

$$\underset{\text{Hofmann's isocyanid.}}{\mathrm{N}\left\{\begin{matrix}\text{Є}^{ii}\\ \text{Є}\mathrm{H}_3\end{matrix}\right.}\qquad\qquad \underset{\text{Acetonitrile.}}{\text{Є}^{iv}\left\{\begin{matrix}\mathrm{N}^{iii}\\ \text{Є}\mathrm{H}_3\end{matrix}\right.}$$

To explain the relations of these substances to water we have the equations

$$\underset{\text{Isocyanid.}}{\mathrm{N}\left\{\begin{matrix}\text{Є}^{ii}\\ \text{Є}\mathrm{H}_3\end{matrix}\right.}+2\mathrm{H}_2\Theta=\underset{\text{Methylamine.}}{\mathrm{N}\left\{\begin{matrix}\mathrm{H}_2\\ \text{Є}\mathrm{H}_3\end{matrix}\right.}+\underset{\text{Formic acid.}}{\text{Є}\mathrm{H}_2\Theta_2}$$

$$\underset{\text{Acetonitrile.}}{\mathrm{C}^{iv}\left\{\begin{matrix}\mathrm{N}^{iii}\\ \text{Є}\mathrm{H}_3\end{matrix}\right.}+2\mathrm{H}_2\Theta=\underset{\text{Acetic acid.}}{\text{Є}^{iv}\left\{\begin{matrix}\text{Є}\mathrm{H}_3\\ \Theta^{ii}\\ \Theta\mathrm{H}\end{matrix}\right.}+\mathrm{NH}_3.$$

In the same manner we easily explain the difference between the cyanetholine of Cloez and ordinary cyanic ether, and recognize in general the existence of two parallel series of cyanogen compounds. In two later communications, Dr. Hofmann has given further details of his very interesting investigation. When an alcoholic solution of ethylamine and chloroform is gradually poured into a retort containing caustic potash a violent reaction ensues, and among the products of the distillation cyanid of ethyl is formed as a liquid possessing an intolerably penetrating odor. The author has not yet carefully studied this body but gives a more detailed account of the cyanid of amyl. This last as obtained by a similar reaction is a colorless liquid smelling of amyl and of cyanhydric acid. Its vapor impresses the tongue with an insupportable bitterness and causes, like cyanhydric acid, a sense of suffocation in the throat. It boils at 137° C., which is 8° lower than its isomer capronitrile. The cyanid of amyl is but slightly attacked by alkalies but acids transform it into formic acid and amylamine. Transient intermediate products are formed in this reaction.

Anhydrous phosphoric acid, as is well known, readily converts the salts of ammonium with the fatty acids into the corresponding nitriles. It was therefore natural to suppose that the cyanids might be formed by a similar reaction, so that, for example, formate of amylamine would yield cyanid of amyl. Dr. Hofmann found however that the action of phosphoric acid was in these cases more profound and did not yield the results expected. On the other hand the author calls attention to the fact that in the preparation of the nitriles by the action of sulphomethylate, &c., of potassium upon cyanid of potassium, the raw nitrile obtained possesses a most offensive odor, while the nitriles obtained by the action of phosphoric acid upon salts of ammonia have a very agreeable aromatic smell. On repeating the older experiments of E. Meyer upon the action of organic iodids upon cyanid of silver, Dr. Hofmann found that in this also the cyanids are formed in considerable quantities. The reaction succeeds best with the iodid of amyl, but much amylene and cyanhydric acid are formed at the same time. The author hopes to obtain the dicyanid of ethylene, $\text{Ꞓ}_4\text{H}_4\text{N}_2$, isomeric with Simpson's cyanid, by the action of chloroform upon ethylene-diamin, or by treating cyanid of silver with iodid of ethylene. He considers it as probable that there exists a corresponding isomeric series of sulpho-cyanids.—*Comptes Rendus*, I, lxv, 335, 389, 448. W. G.

2. *On the same subject.*—Dr. Hofmann's communications on subject of the isomeric cyanids have called out a reclamation of priority on the part of M. Gautier, whose results agree with those of Dr. Hofmann as regards the action of the organic iodids upon cyanid of silver.—*Comptes Rendus*, lxv, 468. W. G.

3. *On certain hydrocarbons contained in coal-tar.*—BERTHELOT has discovered in coal-tar various hydrocarbons which had not hitherto been observed in that liquid as well as several wholly new substances of great interest. Of the former class the author mentions styrolene, $C_{16}H_8$, first in order, as one of the bodies obtained by the transformation of acetylene. The existence of cymene, $C_{20}H_{14}$, in coal-tar has been observed by several chemists, the liquid boiling at 166° C., proving to be cumolene, $C_{18}H_{12}$. Cymene boils at about 180° C., and exhibits the ordinary reactions of the benzol series. When heated to 280° C., with 80 parts of a saturated solution of iodhydric acid, cymene yields hydruret of decylene, $C_{20}H_{22}$, which boils between 155° and 160° C. The author has also found in coal-tar two hydrurets of naphtaline, $C_{20}H_{10}$, and $C_{20}H_{12}$; a hydruret of acenaphtene, $C_{24}H_{12}$, which is a liquid boiling at 260°, and a hydruret of anthracene which is also liquid and boils at 285° C. Fluorene is the name given by the author to a new hydro-carbon which separates in the distillation of the heavy oils. It is a white crystalline substance which exhibits a magnificent violet fluorescence and possesses a sweetish and irritating odor. It fuses at 113° and melts at 305°, and is very soluble in boiling alcohol. The solution of this body in sulphuric acid is colorless, but the least trace of nitrous acid colors it green, and more nitrous acid gives a violet color. Fluorene gives a red crystalline compound with picric acid.—*Comptes Rendus*, lxv, 465. W. G.

II. MINERALOGY AND GEOLOGY.

1. *Note on the genus Palæacis* Haime, 1860 = (*Sphenopoterium* M. & W., 1866); by F. B. MEEK.—At the time the name *Sphenopoterium* was proposed for this genus by Meek and Worthen, the volume of the *Histoire Naturelle des Coralliaires*, in which the lamented Haime had a short time previously described it under the name, *Palæacis*, had not reached this country; nor was it until very recently received at any of the libraries at Washington, where we were then investigating the Illinois fossils. Owing to the fact that for a long time previous to the publication of the Illinois Report, our investigations were pursued in the west, where we were to a great extent cut off from foreign periodical scientific publications, we were also not aware of the fact, until after the printing of the Illinois Report, that von Seebach had called attention in *Zeitschr. der Deutsch. geol. Gessellsch.*, xviii, to the identity of *Palæacis* and *Sphenopoterium*:—otherwise we would have cheerfully adopted the name *Palæacis*, which has priority of date, and must take precedence.*

In first publishing a notice of this genus in 1860, we regarded it as a Coral, as Haime had also done. Milne Edwards, however, in publishing Haime's name and description, expressed some doubts, it appears, whether it is a coral, but left it provisionally where Haime had placed it, in the "*Zoantharia perforata*," or perforated section of Corals.

Being in considerable doubt in relation to the affinities of this genus at the time we were preparing the descriptions for the Illinois Report, and not being where we could have access to all the works on analogous fossils, we sent specimens of our species, *P. obtusa*, to Prof. Verrill, who has made an especial study of the corals, with the request that he should give us some suggestions in regard to the relations of the genus. After as careful an examination as could be made without preparing sections for the microscope, Prof. Verrill informed us that he was inclined to regard it as a Sponge, and not a Coral, which view was adopted by us, on his authority, in the Illinois Report.

Feeling a desire to settle more definitely, if possible, the question in relation to the affinities of this group, I recently prepared a section, as thin as the condition of the fossil would permit, of *P. obtusa*, and sent it to Prof. Verrill, who writes as follows:—

"The section of *Palæacis obtusa* sent to me is not sufficiently thin and transparent to be used with the higher powers, but I have made a somewhat careful examination of its structure as shown under powers below a quarter inch. The internal structure, like the external character, is entirely unlike any known coral, living or fossil, but agrees very well with several forms of fossil sponges. The section has been made vertically across the shorter diameter, through two of the cups. There is a central, imperfectly bounded

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* Von Seebach is in error, however, in saying our description was published in 1861, as it was issued in 1860, but after Haime's, if I am not mistaken.

area beneath the cups, which is traversed by numerous irregular, crooked, sometimes branching canals, which also pass in all directions through the surrounding tissue, but in less numbers; outside of the central area there are seen radiating darker and lighter lines, which appear like minute canals. They are often branched and quite irregular. When highly magnified the whole mass seems composed of a fine spongy tissue, which varies in density between the minute canals, thus giving rise to the darker and lighter lines. There is no appearance of vesicles, or anything like septa or plates, either vertical or horizontal, or walls of any kind around the cells. The only resemblance to corals seems to be in the external form, and radiating striæ of the cells, which, however, are not true septa, and are quite irregular like the striæ in the cups of many fossil and living sponges."

It may not be out of place in this connection, to state that I have scarcely any doubts, after examining a good series of specimens, that the two species, *Palæacis umbonata* and *P. cymbia*, proposed by von Seebach, are mere varieties of *P. obtusa* M. & W., which varies greatly in the characters upon which he has proposed to separate these two forms.

III. BOTANY AND ZOOLOGY.

1. *Monographia Salicum, auctore* N. J. ANDERSSON.—Part I. of this Monograph of Willows, which was communicated to the Royal Swedish Academy of Sciences at Stockholm, in October, 1863, is now published, in vol. 6, of its Transactions, and separately issued, in 4to, pp. 180, with 9 plates, crowded with figures of the details of about one hundred species. We have here about three-fourths of the systematic part, in advance of the elaboration in DeCandolle's Prodromus, which is, by this time, also printed off. The second part will contain the rest of the species, the *generalia*, &c.

The system of arrangement is simple; the primary groups, or tribes, are only three, and founded on the stamens. They are: the *Pleiandræ*, with 3 to many stamens, divided into the *Tropicæ* and the *Temperatæ*, and these, each into three or four ultimate sections; *Diandræ*, with two distinct stamens, much the largest group, divided into the *Microstylæ*, of four sections, the *Podostylæ*, of ten, and the *Macrostylæ*, of four; and finally the *Synandræ*, with two sections. These names indicate clearly the characters of the groups. The present part ends with the *Podostylæ*, and with species 105. As respects the European Willows, Dr. Andersson agrees with Wimmer, (whose elegant treatise was recently noticed in this Journal,) and accordingly regards many admitted species as of hybrid origin; but he unfortunately permits several, recognized as hybrids, to retain the rank of species. Under the principal types, a series of what may be termed sub-species, are coördinated. When the concluding part of this most important and faithful monograph comes to hand, we may hope to prepare a full abstract of the work, as far as relates to North American species, east of the Rocky Mountains. Perhaps it is not too late to suggest to the author a revocation of the name of the 92d species, *S. Novæ-anglicæ*, under which the author has combined two sub-species and several varieties, no one of which is recorded as inhabiting our New England States, or any district nearer than Saskatchawan and the Rocky Mountains. A. G.

2. *Flora Brasiliensis of* MARTIUS.—The 42d and 43d fascicles of this great work, were issued in April last. One includes the *Rosaceæ*, by Dr. J. D. Hooker, with 22 plates, done in Germany. Of the *Rosaceæ*, truly indigenous to Brazil, a little over 100 in number, 95 (under 7 genera) are of the suborder *Chrysobalanæ*. The other fasciculus is devoted to the *Combretaceæ*, by Dr. Eichler, about 65 species, under 9 genera, two of them established by Dr. Eichler, in his revision of the order, and illustrated by 15 plates. A. G.

3. *Lois de la Nomenclature, redigées et commentées* par M. ALPH. DECANDOLLE. Paris: Masson, 1867, pp. 60, 8vo.—This important pamphlet was printed, in August last, upon the request of a Committee of the Botanical Society of France, raised for organizing an International Botanical Congress, which, accordingly, was held in Paris at the close of the summer. The propositions, systematically drawn up and ably expounded by M. DeCandolle, have since been approved by this Congress, with some slight modifications, and recommended by it for general adoption. They seem to us to be, in almost all respects, judicious and timely. Upon receiving the report of the proceedings of this Congress, we may call attention to this revised code, or present to our readers a full abstract of it. A. G.

4. Those features of the botany of Japan and adjacent regions, which are of the highest interest to us, have recently been considered by Miquel in a pamphlet, entitled—

Sur les Affinités de la Flora du Japan avec celles de l'Asie et de l'Amerique du Nord, (extr. des Archives Néerlandaises, ii, 1867.)—The first special notice of the now familiarly known relationship of Japan with Eastern United States botany, was probably given in this Journal, many years ago, in a review of the earlier parts of Siebold and Zuccarini's Flora Japonica. Of the article in the Memoirs of the American Academy, vol. 6, in which the subject is treated in detail, Prof. Miquel is hardly correct in stating, that it was written under the influence of the Darwinian hypothesis. Mr. Darwin's famous volume, if published, had not reached this country when this paper was read, although its leading idea was known here. All that is allowed in the memoir is, the probability "that what are termed closely related species may, in many cases, be lineal descendants from a pristine stock, just as domesticated races are;"—a proposition which, perhaps, very few naturalists would now contest.

It is by some oversight that Prof. Miquel credits only a single *Hydrangea* to North America, restricts *Malvastrum* to Eastern North America, while it is wanting east of the Mississippi, and abounds west of the Rocky Mountains, and deprives the eastern side of *Prosartes*. So far as we know, it is a mistake to credit *Symplo-*

carpus (*Lysichiton* being separated) to the western, as well as the eastern side; and *Cymopterus*, in the same table (p. 16), must be replaced by *Phellopterus* or *Glehnia*, whichever may secure the right of priority. It is very interesting to note that there is, in Japan, a true *Symplocarpus*, if not *S. fœtidus* itself; and even more so, that *Croomia pauciflora*, sole representative of the group in our Southern Atlantic States, has been identified in Japan. The general theoretical views in explanation of these facts of distribution, as given in the matter referred to, are repeated, and more or less reinforced, at the close of Prof. Miquel's interesting *brochure*.

A. G.

5. *Tall Trees in Australia.*—It would appear that the famous "mammoth trees" of California are not only rivalled, but surpassed in height, in Victoria Colony, Australia. The principal facts which warrant this conclusion, are collected by Dr. Ferdinand Müller, Director of the State Garden at Melbourne, in his interesting pamphlet, recently issued, upon "Australian Vegetation, considered especially in its bearings upon the occupation of the Territory, and with a view of unfolding its resources,"—from which the subjoined extracts are derived:—

"The marvellous height of some of the Australian, and especially Victorian trees, has become the subject of closer investigation, since of late, particularly through the miners' tracks, easier access has been afforded to the back-gullies of our mountain-system. Some astounding *data*, supported by *actual* measurements, are now on record. The highest tree previously known was a *Karri-Eucalyptus* (*Eucalyptus colossea*), measured by Mr. Pemberton Walcott, in one of the delightful glens of the Warren river of Western Australia, where it rises to approximately 400 feet high. Into the hollow trunk of this Karri, three riders, with additional pack-horse, could enter and turn in it without dismounting. On the desire of the writer of these pages, Mr. D. Boyle measured a fallen tree of *Eucalyptus amygdalina*, in the deep recesses of Dandenong, and obtained for it the length of 420 feet, with proportions of width, indicated in a design of a monumental structure placed in the exhibition; while Mr. G. Klein took the measurement of a eucalyptus on the Black Spur, ten miles distant from Healsville, 480 feet high! Mr. E. B. Hayne obtained, at Dandenong, as measurements of height of a tree of *Eucalyptus amygdalina*: Length of stem from the base to the first branch, 295 feet; diameter of the stem at the first branch, 4 feet; length of stem from first branch to where its top portion was broken off, 90 feet; diameter of the stem where broken off, 3 feet; total length of stem up to place of fracture, 365 feet; girth of stem three feet from the surface, 41 feet. A still thicker tree measured, three feet from the base, 53 feet in circumference. Mr. George W. Robinson ascertained, in the back-ranges of Berwick, the circumference of a tree of *Eucalyptus amygdalina* to be 81 feet at a distance of four feet from the ground, and supposes this eucalypt, towards the sources of the Yarra and Latrobe rivers, to attain a height of half a thousand feet. The same gentleman found *Fagus Cunninghami* to gain a height of 200 feet, and a circumference of 23 feet.

"It is not at all likely that, in these isolated inquiries, chance has led to the really highest trees, which the most secluded and the least accessible spots may still conceal. It seems, however, almost beyond dispute, that the trees of Australia rival in length, though evidently not in thickness, even the renowned forest-giants of California, *Sequoia Wellingtonia*, the highest of which, as far as the writer is aware, rise, in their favorite haunts at the Sierra Nevada, to about 450 feet. Still, one of the mammoth-trees measured, it is said, at an estimated height of 300 feet, 18 feet in diameter! Thus to Victorian trees, for elevation, the palm must, apparently, be conceded. A standard of comparison we possess in the spire of the Münster of Strasburg, the highest of any cathedral of the globe, which sends its lofty pinnacle to the height of 466 feet, or in the great pyramid of Cheops, 480 feet high, which, if raised in our ranges, would be overshadowed, probably, by Eucalyptus trees.

The enormous height attained by not isolated, but vast masses of our timber-trees, in the rich diluvial deposits of sheltered depressions within Victorian ranges, finds its principal explanation, perhaps, in the circumstance, that the richness of the soil is combined with a humid geniality of the climate, never sinking to the colder temperature of Tasmania, nor rising to a warmth less favorable to the strong development of these trees in New South Wales, nor ever reduced to that comparative dryness of air which, even to some entent in the mountain-ravines of South Australia, is experienced. The absence of living gigantic forms of animal life amidst these, the hugest forms of the vegetable world, is all the more striking.

Statistics of actual measurement of trees, compiled in various parts of the globe, would be replete with deep interest, not merely to science, but disclose, also, in copious instances, magnitudes of resources but little understood up to the present day. Not merely, however, in their stupendous altitude, but also in their celerity of growth, we have, in all probability, to accede to Australian trees the prize. Extensive comparisons, instituted in the Botanic Gardens of this metropolis, prove several species of Eucalyptus, more particularly *Eucalyptus globulus*, and *Eucalyptus obliqua*, as well as certain Acacias—for instance, *Acacia decurrens*, or *Acacia mollissima*—far excelling, in their ratio of development, any extra-Australian trees, even on dry and exposed spots, such into which spontaneously our blue gum-trees would not penetrate. This marvelous quickness of growth, combined with a perfect fitness to resist drought, has rendered many of our trees famed abroad, especially so in countries where the supply of fuel or of hardwoods is not readily attainable, or where for raising shelter, like around the cinchona-plantations of India, the early and copious command of tall vegetation is of imperative importance. To us here this ought to be a subject of manifold significance. I scarcely need refer to the fact, that for numerous unemployed persons, the gathering of Eucalyptus seeds, of which a pound weight suffices to raise many thousand trees, might be a source of lucrative and extensive employment; but on this I wish to dwell, that in Australian vegetation we probably possess the means of obliterating the rainless zones of the globe, to spread at last woods over our deserts, and thereby to mitigate the distressing drought, and to annihilate, perhaps, even that occasionally excessive dry heat evolved by the sun's rays from the naked ground throughout extensive regions of the interior, and wafted with the current of air to the east and south, miseries from which the prevalence of sea-breezes renders the more littoral tracts of West and North Australia, almost free. But in the economy of nature the trees, beyond affording shade and shelter, and retaining humidity to the soil, serve other great purposes. Trees, ever active in sending their roots to the depth, draw unceasingly from below the surface-strata, those mineral elements of vegetable nutrition on which the life of plants absolutely depends, and which, with every dropping leaf, is left as a storage of aliment for the subsequent vegetation. How much lasting good could not be effected, then, by mere scattering of seeds of our drought-resisting acacias and eucalypts and casuarinas, at the termination of the hot season, along any watercourse, or even along the crevices of rocks, or over bare sands or hard clays, after refreshing showers? Even the rugged escarpments of the desolate ranges of Tunis, Algiers, and Morocco, might become wooded: even the Sahara itself, if it could not be conquered and rendered habitable, might have the extent of its oases vastly augmented; fertility might be secured again to the Holy Land, and rain to the Asiatic plateau, or the desert of Atacama, or timber and fuel be furnished to Natal and La Plata. An experiment, instituted on a bare ridge near our metropolis, demonstrates what may be done."

A systematic catalogue of the known trees of Australia, with indications of their territorial distribution, occupies 18 pages of this essay; from which it appears, that in Australia, no less than 950 woody plants attain a height of at least 30 feet, or thereabouts.

A. G.

6. *Report on the disastrous effects of the destruction of Forest Trees now going on so rapidly in Wisconsin;* by I. A. LAPHAM, J. G. KNAPP, and H. CROCKER, Commissioners [appointed by the Legislature of the State]. Madison, Wisconsin, 1867, pp. 104, 8vo. —The topic so properly discussed by Dr. Mühler for Australia (in the above extract), is brought home to our attention in this essay, which we trust will be widely read and seriously considered. The essay has reached our hands too late for the preparation of an abstract, and for specially noting many interesting points in matters of climatology or vegetable physiology, some few of which might be more or less criticised. But the Report as a whole strikes us as sound and able, as well as timely.

A.G.

7. *Annales Musei Botanici Lugduni Batavi* edidit F. A. G. MIQUEL. Tom. I–III, fasc. 4. 1863–1867, fol.—Since our announcement of this work, and analysis of the contents of the earliest fas-

ciculi, in 1864, it has been so indefatigably prosecuted by Prof. Miquel, that two large volumes have been completed, and the third is well under way. A large portion is naturally devoted to Japanese botany, in the 2d and 3d volumes, under the separate heading of *Prolusio Floræ Japonicæ;* and these prolusions are also separately published. When finished, as they are likely soon to be, they will form a nearly complete exposition of Japan botany, as far as is exemplified in the rich and long-accumulated stores of the Leyden herbarium. The various and interesting contents of these volumes invite attention and remark on every side, but are already much too extensive to be compassed here. They comprise considerable monographs, or detailed articles, by collaborators, such as Mettenius, Schott, Hasskarl, DeVriese, &c., who have already passed off the stage, as well as by Sande Lacoste, Oudemans, and others, who are still active; but the greater part of the Japanese botany is Prof. Miquel's own work. In the second volume is an interesting article on *Nymphæaceæ*, by Caspary, with new sections of *Nymphæa*, and an exhaustive analysis of oriental species, a new discrimination of *N. alba* from *N. odorata*, and considerable details upon the variations of the latter, commending them, moreover, to the scrutiny of North American botanists upon the live plants. Of *Nuphar*, he admits three 5-sepalled species; *N. Japonicum* (which he fully describes and figures, both yellow and reddish forms), *luteum*, and *pumilum* (*Kalmianum*).

In characterizing his two primary sections of *Nymphæa*, Dr. Caspary proposes to restrict the botanical term "*connata*," to the case of the junction of organs which were at first separate, and to use the term "*conjunctim enata*," for the ordinary case of primordial union. It were certainly desirable, for clearness, to express the two things by different, rather than identical language; but Caspary's appropriation of the term *connate*, is open to the three objections,—1st, that it is thus divorced from the sense which it generally bears in descriptive botany, and also, 2d, which befits its literal meaning (*born with* the union), while, 3d, it does not etymologically answer well to the use he puts it to. If really needful to restrict any word to designate the comparatively rare case of post-genital union, *coalita* would be the fitter one, and would involve less change of recognized botanical language.

The depressed umbelliferous plant, published by the present writer in Cooper and Suckley's botanical report of Stevens' Pacific Railroad Exploration as *Cymopterus? littoralis*, and referred to in the account of C. Wright's Japan collection (since then collected in Japan by Maximowicz, &c.) has now two genuine names, of which the relative priority is yet uncertain. In Bentham and Hooker's Genera Plantarum, p. 905, which is by this time published in England, it is described as the genus *Phellopterus;* in Maximowicz's admirable collections it is distributed, and in Miquel's Annales, 3, p. 61 (1867), it is enumerated, but not characterized, as *Glehnia littoralis*, F. Schmidt, Fl. Sanchal, ined."

7. *Synopsis of the species of Starfishes, in the British Museum, with figures of some of the new species;* by JOHN EDWARD GRAY, Ph.D., 67 pages, quarto, with 16 plates, London, John Van Voorst. This work includes descriptions of the numerous new genera and species described by Dr. Gray in the Annals and magazine of Natural History, 1840, and the Proceedings of the Zoölogical Society of London, 1847, the plates, which were prepared for a more extended work at the time of the original publication of the species and have since been laid aside, are very accurate and beautifully executed, representing, in most cases, species not before figured. The descriptions are reproduced from the original papers with the addition of some synonyms, and lists of addittional species. It is greatly to be regretted that the loss of the types of many of the new species, especially those from the west coast of America, collected by H. Cuming, Esq., prevents their being figured or more fully described. This work, however, will be extremely valuable to all investigators of this interesting group of animals on account of the many excellent figures of rare and remarkable species. V.

IV. ASTRONOMY.

1. *Discovery of new planet* (93).—Prof. WATSON discovered a new planet on the night of the 24th of August. It resembles a star of the 11th magnitude. The following are some of the earlier and later observations, provisionally reduced.

	Ann Arbor M. T.	(93) α	(93) δ
1867, Aug. 24,	$15^{h}\ 13^{m}\ 22^{s}{\cdot}1$	$0^{h}\ 6^{m}\ 48{\cdot}^{s}40$	
24,	16 5 52·0	0 6 46·86	−3° 11′ 48·″3
25,	10 2 42·9	0 6 17·04	3 13 7·7
25,	10 17 51·1	0 6 16·80	3 13 7·3
26,	10 47 51·4	0 5 36·35	4 42 55·3
Oct. 15,	9 48 5	23 24 30·35	4 42 25·3
16,	9 48 32	23 23 58·00	−4 42 20·5

2. *Discovery of new planet* (94).—Prof. WATSON discovered another new planet, also resembling a star of the 11th magnitude, on the night of the 6th of September. The following are the earlier and later observations.

	Ann Arbor M. T.	(94) α	(94) δ
1867, Sept. 6,	$14^{h}\ 48^{m}\ 10^{s}{\cdot}1$	$0^{h}\ 56^{m}\ 33^{s}{\cdot}46$	
6,	16 15 37·4	0 56 31·34	+6° 11′ 14″·5
7,	10 12 21·4	0 56 6·99	6 10 42·2
8,	9 59 29·2	0 55 33·40	6 0 54·7
Oct. 15,	11 35 6	0 27 23·20	4 55 28·9
16,	10 30 4	0 26 40·34	+4 53 19·6

3. *Shooting Stars in August*, 1867.—At New Haven it was cloudy on the nights of 9–10th and 10–11th of August.

(1.) *At Philadelphia.*—The following is the result of the watch on the morning of the 10th, by Mr. B. V. Marsh, and Mr. C. H. Darlington, each watching independently of the other, and directing their attention mainly toward Perseus.

Time.	*B. V. Marsh.*		*C. H. Darlington.*	
	conf.	non-conf.	conf.	non-conf.
1^h 3^m to 1^h 45^m	10	7	10	4
1 45 " 2 0	6	4	6	1
2 0 " 2 15	3	0	3	1
2 15 " 2 30	3	2	1	1
In 1^h 27^m	22	13	20	7

Seven of those seen by Mr. Marsh, and six seen by Mr. Darlington were estimated to have been bright enough to be visible in moonlight. The meteors originating near the radiant indicated the usual position, while some of the more distant seemed to proceed from Cassiopeia. Several had trains but they were not persistent nor were they very bright. The next night the sky was overcast.

(2.) *At Marathon, N. Y.*—Mr. Lewis Swift saw none during an hour's watching between 9^h and 10^h P. M., Aug. 9th. Resuming observation in the morning he saw (watching alone) in 1^h 10^m, beginning at a quarter past two o'clock, 39 meteors. Thirty-four were conformable to a radiant in Perseus. Three larger than any of the 34 had a radiant in R. A. 3^h 30^m, Dec.+27°. The paths were generally short. One not more than $\frac{1}{8}$ of the moon's diameter in length was 1° from γ Persei. Fog prevented further observations.

The evening of the 10th was cloudy. At 3 o'clock on the morning of the 11th, 17 were counted in 30 minutes, when the fog again interfered. The radiant point for 15 of them was thought to be slightly removed from its place on the previous morning.

Aug. 12th, in 15^m from 2^h A. M., 7 were seen, all conf.
" " 60^m " $9\frac{1}{2}^h$ P. M., 3 " " 2 conf.
" 13th, 30^m " 1^h A. M., 2 " " both "

Mr. Swift paid special attention to the number of meteors visible, and to the location of the radiant. The latter he places on the

10th (A. M.),	in R. A.	2^h 50^m,	N. P. D. 37°.
11th "	"	2^h 55^m,	" 38°.
12th and 13th "	"		doubtful.

The diameter of the circle of radiation was estimated at from 6° to 8°.

(3.) *At Winchendon, Mass.*—Mr. F. W. Russell reports in the early part of August, 6 or 7 meteors per hour, all radiating from near Aquila. The first specific August meteor was seen about the 5th, and the radiant during the next few days was in Cassiopeia. It gradually passed down into Perseus.

Aug. 7th. From 9^h 45^m to 10^h 45^m P. M., 8 meteors, all from radiant near ϵ and δ Cassiopeia.

Aug. 9th. From 12^h 15^m to 12^h 55^m A. M., 7 conf., 10 non-conf.
Aug. 9th. Evening. A few large meteors from η Persei.
Aug. 11th. From 2^h to 3^h A. M., 28 conf., 0 non-conf.
" " " 3^h to 3^h 40^m " 15 " 1 "

Those marked conformable all diverged from an area 25° in diameter whose center was R. A. 44°, N. P. D. 31°. Thirty-three were from an area 5° in diameter, whose center was R. A. 47° 45′, N. P. D. 31°.

Aug. 12th. From 2^h to 3^h (hazy) 18 conf. 2 non-conf.
" " " 3^h to 3^h 30^m (clear) 23 " 2 "

About $\frac{3}{4}$ths of the paths produced backward, crossed a circle 16° in diameter, whose center was in R. A. 50°, N. P. D. 33°. This was considered to be as nearly as could be determined the center of the area of emanation. Mr. Russell adds: "It was emphatically evident that the position of the radiant on the 11th, was not that of the 12th. The area had moved toward μ Persei, and a little toward α also. Moreover the area seemed elliptical, the major axis being in declination and with a ratio to the minor axis of 5 : 2."

Mr. Russell watched alone and was interrupted frequently by the clouds and fogs.

(4.) *At Florence.*—Prof. Donati reports (Bulletitno Meteor., Sept. 1867) the following results of observations made at Florence this year.

1867. Aug.	No. of observers.	Number of shooting stars seen. 9^h–10^h	10^h–11^h	11^h–12^h	12^h–1^h	1^h–2^h	2^h–3^h	3^h–4^h	Total.
9–10	3	6	35	25	29	51	61	30	237
10–11	4	32	48	39	50	122	160	106	557
11–12	3	27	27	30	34	53	94	86	351
12–13	2	6	24	12	14	18	28	28	130
13–14	1	3	6	6	6	9	7	10	47

Of these 1322 meteors, 972 were recorded as conformable and 350 unconformable. The maximum deduced from this table was from two to three o'clock on the morning of the 11th of August.

H. A. N.

4. *Meteoric Astronomy.* A treatise on Shooting Stars, Fireballs and Aerolites; by Prof. DANIEL KIRKWOOD. 12mo, pp. 130, Philadelphia, J. B. Lippincott & Co. 1867.—This little treatise gives in a popular form a summary of the more important astronomical relations of the igneous meteors. In addition the author discusses the relations to the nebular hypothesis of the knowledge recently acquired respecting them. The work constitutes a valuable and interesting contribution to our literature upon this subject.

Some inadvertencies ought, however, to be corrected in any future edition. For example, he ascribes (p. 27) the change of the epoch of the August meteors from the 25–28th of July in the 9th century to the 9–11th of August in the 19th, to a motion of the nodes of their orbits along the ecliptic. The amount of motion is, however, hardly perceivable, when allowance is made for the precession of the equinoxes, and for the change of the calendar. In his list of April showers some dates are improperly included and others improperly omitted. Again, in the accounts of the April, August and December meteors, more credit, we think, should have been given to Mr. Herrick's investigations. This oversight is probably due to the fact that the author did not attempt to write the history of the subject. But the frequent references to other laborers in this field of science make the omission noticeable. H. A. N.

5. *On Meteors in the Southern hemisphere;* by Dr. E. HEIS and Dr. GEORGE NEUMAYER. Mannheim, 1867, 24 pp. 4to, (reprinted from Dr. Neumayer's "Discussion of Met. and Magn. Obs. made at the Flagstaff Observatory.")—This memoir is very important as giving almost the only observations we have of meteors observed in the southern hemisphere. The paths of 2088 meteors seen between March, 1858, and October, 1863, at the Flagstaff Observatory, at Melbourne, are discussed by Dr. Heis. One of the most noticeable results is the lack of unusual numbers of meteors on the 10–12th of August. This was to have been expected as the radiant in Perseus is below the horizon at Melborne.

6. *Sternschnuppen und Kometen,* (Extr. from "Kalender für alle Stände") by Carl von Littrow. Vienna, 1867, pp. 42, 8vo.—This is a history and summary of the recent investigations which have led to the important discovery of the intimate relation between shooting stars and comets.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Ascent of Mt. Hood, in Oregon, and determination of its height.*—Lieut. Col. Williamson, U. S. Engineers, has just communicated to the California Academy of Natural Sciences an account of his successful attempt to fix the height of this famous and much controverted mountain. We extract the essential part of it, as follows:

"The stations used were Astoria, Fort Vancouver, Fort Dalles, camp on slope of Mount Hood, and summit of Mount Hood. Observations had been taken for several years at Astoria for me by Louis Wilson, United States Tidal Observer, at 7 A. M., 2 P. M., and 9 P. M., of every day, besides hourly observations for ten days or more of each month. The cistern of this barometer is 53 feet above mean low tide.

"At Fort Vancouver, observations of the same character were commenced July 1st of this year, and are still going on. At Fort Dalles similar observations have been made since July 10th. The observations at the camp on the mountain slope were commenced at 7 P. M., on August 22d, and continued hourly (with few omissions) until 8 A. M., on the 24th. The barometer at the summit was hung up at 1.30 P. M., August 23d, and allowed to stand a half hour in free air, but protected from the direct rays of the sun. It was there adjusted and observed at 2 P. M., 2:15 P. M., and 2:30 P. M., by Mr. Heuer and Mr. Best independently, and the two records as shown to me were essentially the same. The mean reading of the barometer reduced to 32° Fah. was 19·941 inches, with an observed air temperature of 41·7 and wet bulb of 31·3.

"The height of Fort Vancouver above Astoria was computed from the mean of the simultaneous observations taken during the months of July and August. The height of the Dalles above Fort Vancouver was deduced from the corresponding observations during twenty-one days in July, together with those for the month of August. The height of the camp on the mountain slope above Fort Vancouver, and also the height of that camp above Fort Dalles, were then separately computed from the daily means of the observations taken at the three stations during August 23d. The difference between the two should give the same result as by the direct calculations between Fort Vancouver and Fort Dalles, but, on account of the short period observed on the mountain camp, a plus correction of a little over eight feet was found necessary to the estimated height of that camp to make the three results agree.

"It then remained only to calculate the height of the summit of Mount Hood above the mountain camp. The mean of the three observations of the barometer was assumed as the nearest approximation we can have to the mean pressure for that day, as the horary oscillation at the summit is unknown.

"With regard to the mean temperature for that day, we have no positive data to determine it. We cannot take the observed temperature, as the observations were taken during the hottest part of the day.

"By consulting the hourly observations of the thermometer at the camp, I find the range there is between 63° and 43·7°, or nearly 20°, and supposing nearly as great a range of temperature on the summit, I have assumed the mean temperature there, for that day, to be 34°.

"The following are the final results of the computations:

Stations.	Inter. alt.	Alt. above sea line.
Sea level at mean low tide................		0
Astoria..............................	53	53
Fort Vancouver	79	132
Camp on mountain slope..................	5,820	5,952
Summit of Mt. Hood.....................	5,273	11,225

"The computations are made with new tables, which will shortly be published, and which give results similar to those by Plantamour's formula, based on Regnault's constants. They give the results somewhat higher than if Guyot's tables had been used, the latter giving the height of the summit at 11,185 feet."

The ascent was made on the twenty-third of last August, under very favorable circumstances of weather, and the instruments used (new ones, by James Green, of New York) were brought down in perfect order, and compared with the standard at Fort Vancouver.

With regard to the discordance between his result and that of a party which ascended the mountain a year earlier, and from the temperature, 180° F., at which they observed water to boil, deduced a height of 17,600 feet, Col. Williamson remarks:

"The reason is that the instruments used were unreliable, and this method of computing the altitude defective. With a boiling-point apparatus (or thermo-barometer, as it is called), even of the most approved kind, the results by boiling water are far inferior to those by the cistern-barometer; but if the observations are made by a common thermometer, with small places for degrees, as was the case in this instance, and the instrument not protected from drafts of air, the results are utterly unreliable, and, therefore, worse than worthless."

Prof. J. D. Whitney, State Geologist of California, who visited Oregon this summer, writes (in a private letter) concerning the same ascent: "The measurement of Mt. Hood published abroad by Prof. Alphonso Wood was in reality made by Rev. Mr. Atkinson, of Portland, who carried up his own thermometer (one of Kendall's, with a heavy metallic scale), made the observations, and calculated them by a rule which he found in Porter's Chemistry."

In our May number (vol. xliii, p. 416–9), we quoted from the Proceedings of the Royal Geographical Society a story told by a Rev. H. K. Hines of his own ascent of Mt. Hood, in July of last year, wherein that gentleman distinctly conveys the impression that he, too, had boiled water at 180° upon the summit, and calculated from it a height for the mountain of 17,640 feet, thus confirming Mr. Atkinson's result with a signal, not to say singular, closeness. Prof. Whitney says farther, with reference to this: "Mr. Hines never carried up any instruments at all, as I ascertained on the spot from those who went up with him. I had felt certain of this before, for the simple reason that he had given figures identical with those of Atkinson and Wood, which were evidently erroneous; as also because, in the account which he published in the newspapers on his return, he said never a word about having made any measurements, or having any instruments with him. It is, then, a clear case of piracy."*

Prof. Whitney himself made, during his brief visit, the best trigonometrical observations that circumstances permitted upon the heights of Hood, St. Helens, and Adams, and his results, as yet only rudely worked out, gave him over 12,000 feet for Hood, and about 1,000 feet less for the other two, which appear to be nearly of the same height. Mt. Rainier he was unable to observe, but thinks, judging by the eye alone, that it is the highest of all the mountains of Oregon and Washington Territory. Col. Williamson refers to these measurements as tending to confirm the accuracy of his own; and, while hoping that other parties, with good instruments, will repeat his observations, he yet expresses his confidence that the result he has reached will not be varied a hundred feet.

2. *American Association for the Advancement of Science.*—The sixteenth meeting of the American Association for the Advancement of Science was held at Burlington, Vt., in August last, commencing on Wednesday the 21st and closing on the Monday evening following. The officers of the meeting were Prof. J. S. Newberry, President, Prof. J. Lovering, Permanent Secretary, Prof. C. S. Lyman, General Secretary. The Vice President, Prof.

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* Mr. Hines's claim is not put forward *quite* so categorically as it was represented in our reprint of this article. By an error of the press, his statement, "This was found to be 17,460 feet high, the thermometer standing at 180°," is printed "This *we* found," etc. On the difference between *was* and *we* he would possibly found a claim to save his character for veracity.

W. Gibbs, and the Treasurer, Dr. A. L. Elwyn, were not present. Dr. B. A. Gould was elected chairman of Section A, Mathematics and Physics, and Prof. J. W. Dawson, of Section B, Natural History and Geology.

The whole number of papers read was 63—30 in Section A, and 33 in Section B. The papers, generally, would compare favorably in interest and importance with those of previous meetings.

The attendance of members was about the same as at Buffalo—some seventy-five or eighty. Though not as great, for various reasons, as before the war, it was yet larger than was generally anticipated, and abundantly indicative of the abiding interest felt in the Association by the scientific men of the country. The spirit of the meeting was excellent throughout, and the discussions often of the highest interest. A noticeable feature was the number of the younger men of science who took part, some of them for the first time, and the impression of high promise made by many of them in their several fields of effort. At the same time, the absence of many of the older men, so active in former meetings, could not but be generally remarked. Some had died—among them Prof. Bache; others, like Prof. Henry, were kept away by illness, or other causes.

The meeting was in all respects a successful one, and the Association may now be regarded as permanently re-established, with every prospect of as full an attendance of members, and as happy an influence on the science and the scientific men of the country in the future as at any former period. The success of the meeting was promoted in no small degree by the active coöperation of many of the citizens of Burlington, and the hospitalities and courtesies extended to the Association, both by individuals and corporations, contributed largely to the comfort and enjoyment of the members. The excursion on the Lake and to the Gorge of the Ausable, by invitation of the Champlain Transportation Company, and that to Mount Mansfield by invitation of W. H. H. Bingham, Esq., deserve to be particularly mentioned.

In default of the customary address by the retiring president, (Dr. Barnard being in Europe) the address this year was given by the president, Prof. Newberry, on "Modern Scientific investigation—its Methods and Tendencies."

Among the general business transacted was the appointment of a commission, "To examine the Linnean rules of Zoological Nomenclature by the light of the suggestions and examples of recent writers, and to prepare a code of laws and recommendations in conformity with just modern usage, to be submitted to the Association at the next meeting." The commission, as appointed, consists of Profs. J. D. Dana, J. Wyman, S. F. Baird, J. Leidy, J. S. Newberry, J. W. Dawson, Wm. Stimpson, S. H. Scudder and F. W. Putnam.

Prof. John Torrey was appointed on the committee of Weights and Measures in place of the late Prof. Bache.

Dr. B. A. Gould was appointed to prepare an address on the Life and Services of Prof. Bache, to be delivered at the next meeting.

The next meeting was appointed to be held in Chicago, commencing on Wednesday, the 5th of August, 1868.

The officers elected for that meeting, are Dr. B. A. Gould, President, Col. Charles Whittlesey, Vice President, Prof. J. Lovering, Permanent Secretary, Prof. A. P. Rockwell, General Secretary, Dr. A. L. Elwyn, Treasurer.

The following is a list of the papers read.

IN SECTION A.—MATHEMATICS AND PHYSICS.

1. On the optical method of studying Sound; Prof. J. Lovering.
2. New determination of the distance of the Sun; Prof. Simon Newcomb.
3. Apparatus for illustrating Wave Motion; Prof. C. S. Lyman.
4. On the Theories of Boussingault and Thenard of the difference between Stale and Freshened Bread; Prof. E. N. Horsford.
5. On the relative values of Gold and Silver for a series of years; E. B. Elliott.
6. Remarks on Meteorological results deduced from the new method of registration; Prof. G. W. Hough.
7. Remarks on the laws of winds, with some account of progress in the investigation of the same; Prof. J. H. Coffin.
8. On the Periodicity of the Aurora; Prof. J. Lovering.
9. Occupations of the population classified; E. B. Elliott.
10. On the determination of latitude from observations in the prime vertical; Prof. W. A. Rogers.
11. On new diagrams and derivative symbols, illustrating the prominent characteristics of the chemical elements; Prof. S. D. Tillman.
12. On the Velocity of transmission of signals by the Electro-magnetic Telegraph; Dr. B. A. Gould.
13. On the Structure of Ice in its relations to the sudden disappearance of Ice on Lake Champlain; Prof. E. N. Horsford.
14. The Geodetic Triangulation of the Coast of New England, Prof. Bache, late Superintendent of the U. S. Coast Survey; Prof. J. E. Hilgard.
15. Preliminary notice of Experiments on Snow at temperatures below 32° Farenheit; Prof. E. Hungerford.
16. Remarks on Personal Equation in Transit Observations; Prof. G. W. Hough.
17. Tellurium a Metal; Dr. L. Bradley.
18. On a new method of Measuring Musical intervals upon a spiral projection; S. D. Tillman.
19. Suggestions on the Scientific and Practical Relations of Wood Spirit; Prof. J. Hyatt.
20. On certain Laws of Production and Trade; E. B. Elliott.
21. On the Conversion of Iron into Steel by means of carburetted Hydrogen Gas; Prof. Jas. Hyatt.
22. On the Knowledge of the Satellites of Jupiter before the time of Galileo; Prof. Jas. Hyatt.
23. On the Effects of Sunshine on Fires; Prof. E. N. Horsford.
24. On the Communications of Vibrations; Prof. B. Peirce, read by Prof. Lovering.

25. Indian Architecture; L. H. Morgan.

26. Notes on the Duke of Argyle's theory of the flight of Birds, with illustrations derived from the Trochilidae; L. E. Chittenden.

27. On the use of Months for Dates; J. F. Holton.

28. On Elliptic Integrals by Series; David Trowbridge, presented by Dr. B. A. Gould.

29. On Euler's Universal Formulæ for the Summation of Series; David Trowbridge, presented by Dr. B. A. Gould.

30. On Observations of Venus near inferior conjunction; Prof. C. S. Lyman.

IN SECTION B.—NATURAL HISTORY, AND GEOLOGY.

1. The Distribution of Precious Metals in the United States; Col. Charles Whittlesey.

2. The Geological Relations of the Mastodon and Fossil Elephant of North America; Prof. James Hall.

3. Considerations drawn from the Study of the Orthoptera of North America; Samuel H. Scudder.

4. Traces of Ancient Glaciers in the White Mts.; G. L. Vose.

5. The Origin of the so-called Lignilites or Epsomites; Prof. O. C. Marsh.

6. The Geographical Distribution of the Sediments and the Fossils of the Hamilton, Portage, and Chemung groups of New York; Prof. James Hall.

7. The distribution of Limnæa megasoma and cognate genera; L. E. Chittenden.

8. Upon some remarkable Fossil Fishes obtained by Rev. H. Herzer, from the Devonian Rocks at Delaware, Ohio; Prof. J. S. Newberry.

9. The Fossil Insects of North America; S. H. Scudder.

10. The Winooski Marbles of Colchester, Vt.; Prof. C. H. Hitchcock.

11. The Zoological affinities of the Tabulate Corals; Prof. A. E. Verrill.

12. The Coal Measures of Illinois; Prof. A. H. Worthen.

13. New Points in the Geology of Nova Scotia and New Brunswick; Prof. J. W. Dawson.

14. On some New Fossil Sponges from the Lower Silurian: Prof. O. C. Marsh.

15. On the occurrance of Fossil Sponges in the successive groups of the Paleozoic Series; Prof. James Hall.

16. The American Beaver; Lewis H. Morgan.

17. The Distortion and Metamorphosis of Pebbles in Conglomerates; C. H. Hitchcock.

18. On some Fossil Reptiles and Fishes from the Carboniferous Strata of Ohio, Kentucky, and Illinois; Prof. J. S. Newberry.

19. Cotta's Law of the Earth's Development; R. W. Raymond.

20. On Mountain Masses of Iron Ore in the United States; Col. Charles Whittlesey.

21. On the Lower Silurian Brown Hematite Beds of America; B. S. Lyman.

22. Explanations of the Geological Map of Maine; Prof. C. H. Hitchcock.

23. On the Geographical Distribution of Radiates on the West Coast of America; Prof. A. E. Verrill.

24. Considerations relating to the Climate of the Glacial Epoch in North America; Prof. Edward Hungerford.

25. Depression of the Sea during the Glacial Period; Col. Chas. Whittlesey.

26. Ripton Sea Beaches; Prof. Edward Hungerford.

27. On the Cretaceous and Tertiary Flora of North America; Prof. J. S. Newberry.

28. On certain Effects produced upon Fossils by Weathering; Prof. O. C. Marsh.

29. Geology of Vermont; Prof. C. H. Hitchcock.

30. The Insect Fauna of the summit of Mt. Washington as compared with that of Labrador; Dr. A. S. Packard, jr.

31. Remarks on the Ichthyological Fauna of Lake Champlain; F. W. Putnam.

32. The Embryology of Libellula (Diplax), with notes on the Morphology of Insects, and the classification of the Neuroptera; Dr. A. S. Packard, Jr.

33. On the Flowering of Plants; James Hyatt.

3. *National Academy of Sciences.*—At the recent August meeting of the National Academy of Sciences, held at Hartford, the following papers were presented.

1. The structural character of the Selachians; L. Agassiz.

2. Protest against modern nomenclature in Zoology; L. Agassiz.

3. On homocercy and heterocercy; L. Agassiz.

4. On the significance of classes in the Animal kingdom; L. Agassiz.

5. On sterility among Skates; L. Agassiz.

6. The fifth pair of nerves and the organ of hearing in Skates; L. Agassiz.

7. On periodical orvulation in Sharks and Skates; L. Agassiz.

8. The circulation of blood in Selachians; L. Agassiz.

9. Parasitic Crustacea in the gills of Sharks; L. Agassiz.

10. On the duration of the electric discharge; O. N. Rood.

11. On new processes in analytical chemistry; W. Gibbs.

12. On certain points in the theory of atomicities; W. Gibbs.

13. Spectroscopic notices; W. Gibbs.

14. On determination of wave lengths by the method of comparison; W. Gibbs.

15. Embryology and affinities of Cyclopterus; L. Agassiz.

16. Algebras; Benjamin Peirce.

17. The limitations and conditions of associated linear algebra; Benjamin Peirce.

18. Single, double and triple linear associative algebras; Benjamin Peirce.

19. Quadruple linear associative algebra; Benjamin Peirce.

20. The precision of the equinoxes and rotation as resulting from

the theory of the gyroscope, with remarks explanatory of the deviation of rifled projectiles; G. Barnard.

21. Notes on a problem in curvature; T. Hill.

22. Observations in 1866 and 1867 of right ascensions of stars observed by d'Agelet in 1783–5; B. A. Gould.

23. Determinations of the proper motions of stars first observed by d'Agelet; B. A. Gould.

24. Remarks on the geological relations of the Mastodon and Fossil Elephant, suggested by the discovery of the Cohoes Mastodon; Jas. Hall.

25. On the value of certain groups in the geological series when studied in their geographical extension; Jas. Hall.

26. On a process of integration used in the case of a planet's orbit disturbed by small forces; Theodore Strong.

4. *Mineralogical Nomenclature.*—In my article on Mineralogical Nomenclature, page 146 of this volume, I observe that names after persons were not used by the ancients. I failed to allude to a case cited from Pliny (xxxvi, 67) by von Kobell, in his excellent *Geschichte der Mineralogie* (Munich, 1864)—that of *Obsidian*, or more correctly *Obsian*, named after Obsius, who Pliny says discovered the substance in Ethiopia,—an example referred to in 1790 by Werner in a defense of his own use of such names (Bergm. J., i, 103, 1790). But this is not strictly an example of a personal name of the kind intended. For Pliny uses *Obsian* not as a substantive but as an adjective; the mineral was not *Obsian* but *Obsian glass* or *Obsian stone; vitrum obsianum, lapis obsianus*, and *obsiana* [vitra], occurring in the course of the paragraph. The addition of the termination *ite* to Obsian would, according to mineralogical method, make a name equivalent to Pliny's *lapis obsianus.* Names of persons ending in *an* (as Octavian, Tertullian) were common among the Romans; and this is so far reason for avoiding the termination in names of stones.

Some critics question the existence of the reputed Obsius, and reject Pliny's explanation. J. D. DANA.

5. *British Association.*—The British Association was in session at Dundee in September last, commencing its session on Wednesday the 4th. The names of over 2000 attendants on the meeting were enrolled, of whom more than 700 were ladies. The President of the year, the Duke of Buccleuch, opened the meeting with a brief and popular address, much less labored and scientific than the Association has been accustomed to hear from its President. The receipts for the year past amounted to £787, and the expenditures to £777. We have not space at this time for a notice of the various papers presented.

6. *Walker Prizes of the Boston Society of Natural History.*—The subjects for the annual prizes of 1868 and 1869, are as follows: For 1868, Adduce and discuss the evidences of the coëxistence of man and extinct animals with the view of determining the limits of his antiquity. For 1869, On the range of Arctic and Alpine plants in North America, with an enumeration of the species. On the nature of the prizes, see vol. xl, p. 137, of this Journal.

V. MISCELLANEOUS BIBLIOGRAPHY.

1. *The Mechanical Theory of Heat with its application to the Steam Engine, and to the physical properties of bodies;* by R. Clausius, Prof. of Physics in the University of Zurich, edited by Prof. T. Archer Hirst, F.R.S., with an introduction by Professor Tyndall. London, John Van Voorst, 1867. 8vo, pp. 376.—This volume consists of nine memoirs by Prof. Clausius which were originally published in Poggendorff's Annalen and elsewhere. In 1864 the author prepared for the press a collected edition of them, adding notes and appendices. The present volume is an English edition containing, however, an additional memoir (the 9th) which has appeared since 1864. The 5th memoir was reprinted in this Journal, (II, xxii and xxiii) from the Philosophical Magazine.

The following are the titles to the memoirs. Introduction; On the treatment of differential equations which are not directly integrable. 1st memoir, On the moving force of heat, and the laws of heat which may be deduced therefrom. 2d, On the deportment of vapor during its expansion under different circumstances. 3d, On the theoretic connexion of two empirical laws relating to the tension and the latent heat of different vapors. 4th, On a modified form of the second fundamental theorem in the mechanical theory of heat. 5th, On the application of the mechanical theory of heat to the steam engine. 6th. On the application of the theorem of the equivalence of transformations to interior work. 7th, On an axiom in the mechanical theory of heat. 8th, On the concentration of rays of heat and light, and on the limits of its action. 9th, On several convenient forms of the fundamental equations of the mechanical theory of heat.

2. *Condition and doings of the Boston Society of Natural History.* Boston, 1867.—In this report are included the reports of the Custodian, the Librarian, the curators of the various special departments, and the Treasurer, together with obituary notices of two prominent and active members of the society, Dr. A. A. Gould and Dr. Henry Bryant. The reports show continued enterprise and activity in all departments of the society, and a highly encouraging financial condition. During the year two important bequests have been received, one of $20,090 from P. P. Pope, Esq., and $10,000, with a valuable collection of shells from Miss S. P. Pratt. Important improvements have been made in the building, for the better accommodation of the rapidly increasing library and collections. The publication of both the Memoirs and Proceedings have gone forward with unusual rapidity, and a volume of the Correspondence and Entomological notes of Dr. T. W. Harris is announced as authorized to be published. During the year forty-four papers have been presented to the Society from thirty-one individuals.

3. *The Culture demanded by Modern Life.*—Under this title Messrs. Appleton & Co. have published a collection of addresses and arguments in favor of scientific training by Faraday, Tyndall, and a number of the most eminent English and American scientists

of the present day. This excellent and useful compilation is due to Prof. E. L. Youmans whose labors in the cause of science are familiar to all and to whom we owe a collection of papers on the correlation of forces as well as original scientific works of great merit. Prof. Youmans has done good service to the cause of scientific education in our country by the preparation of this work. He has brought together a mass of argument from scattered and, to most readers, inaccessible sources. These papers treat the subject from about every point of view. They vary, as might be expected, in ability, but they are without exception readable and interesting. Mr. Youmans's own lecture on the scientific study of human nature is very valuable and suggestive and his introduction to the reader is well written and appropriate. The gem of the work is, in our opinion the noble and characteristic discourse of Faraday on the education of the judgment, and we are glad to see his words put into a permanent form. In conclusion we heartily thank Prof. Youmans for his work and commend it to the earnest attention of teachers. G.

4. *On the distribution of temperature in the lower region of the earth's atmosphere;* by Professor Henry Hennessy, F.R.S. (Ext. Roy. Irish Acad.) 4to, 58 pp.—Professor Hennessy discusses in this memoir the daily change of temperature with reference to the geographical position of the stations. By drawing a line through the places that enjoy the same temperature at the same instant of absolute time, he constructs what he denominates a *synthermal* line. A map containing such lines for 4^{h} A. M. and 2^{h} P. M. Greenwich mean time accompanies the memoir.

5. *Die Chemie der austrocknenden Oele, ihre Bereitung und ihre technische Anwendung in Künsten und Gewerben;* von G. J. Mulder. Nach der holländischen Original-Ausgabe bearbeitet von J. Müller, Berlin, 1867.—Mulder being asked what paint would best serve to protect iron from rusting, was unable to give an answer satisfactory to himself without first experimentally investigating the nature of paint and finding out wherein the drying of oils consists. He has brought to bear on this practical subject, his well known accuracy, tact, and thoroughness, and has obtained commensurate results. He has resolutely and perseveringly grappled the previously evasive Proteus of the drying oils, through its several shapes, and has at last elicited facts and principles which are all the more important for their bearing on matters of everyday life, —for their relation to the arts and to art. Most of his experiments were made on linseed oil, but he also devoted some attention to poppyseed oil and nut oil. The chief and distinctive constituent of all is "linolein" which consists of glycerin and "linoleic acid." The author tried in vain to obtain pure linoleic acid, for the more he worked with it the more it became contaminated with products of oxydation; and, as it is one of the very weak acids, he found it exceedingly difficult to produce salts which he could be sure were quite pure and normal. But there can be little doubt that its composition is $HO,C_{32}H_{27}O_3$. Linoleic acid being exposed in thin layers to the air, in a few days becomes oxydized

to "linoxic acid,"—a sticky substance, like turpentine. By several months farther exposure, the linoxic acid dries and becomes "linoxyn," $C_{32}H_{27}O_{11}$,—an amorphous, tough, leathery matter insoluble in water, alcohol, ether, or dilute acids, but dissolving in alkalis to reproduce linoxates. Its best proper solvent is a mixture of alcohol and chloroform. Linoleate of lead readily oxydizes in the air to a white linoxate, which is not glutinous, but dry, hard, and brittle. And linseed oil boiled with a very little oxyd of lead so as to contain a small quantity of linoleate of lead, dries as well in a few days as isolated linoleic acid does in so many months. There are two linoxyns, the white and the red, and there are corresponding white and red linoxic acids. The white modifications become red by being heated to 80° C., and the red turn white again by continued exposure to sunlight. The browning of white paint in dark places, is owing to the gradual change of white linoxyn into red. Four linoxic acids are mentioned, having the same properties, but differing in respect to color and to the amount of HO in combination. White linoxic acid formed by the oxydation of linoleate of lead, is $HO,C_{32}H_{25}O_9$; that produced by the oxydation of free linoleic acid in the air, is $HO,C_{32}H_{25}O_9+2HO$. Red linoxic acid when separated from red linoxate of lead by chlorhydric acid and dried at 100° C., is $C_{32}H_{25}O_9$. The second of the above white linoxic acids on being heated for some time in a water bath, loses 6·7 per cent and leaves a blood red linoxic acid of the composition $HO,C_{32}H_{25}O_9$. It will be noticed that linoxyn, which is an indifferent substance, has a composition intermediate between this latter red linoxic acid and the white from which it is formed; but of course in linoxyn the molecular arrangement is different. Linoleic anhydrid,—$C_{32}H_{27}O_3$,—completes the list of peculiar substances which exist or may be formed in drying oils. More or less of it is always formed during the boiling of such oils, and it adds much to the goodness of boiled oil. It is an unalterable, elastic matter, like caoutchouc that has been melted.

Poppy seed oil and nut oil differ from linseed oil in containing laurin instead of palmitin, and their linolein gives only the white variety linoxyn. Hence not being liable to turn brown in the dark, they are better for artists' use. Linseed oil consists of about 80 p. c. of linolein, 10 p. c. of elaïn, and 10 p. c. of myristin and palmitin.

Mulder calls attention to what may be called the respiration of drying oils, for when they are spread out over a great surface they absorb oxygen and give out carbonic acid, like the blood of living animals. In drying, linseed oil increases in weight to the amount of from seven to twelve per cent over and above what it loses in the form of water and carbonic acid, together with small portions of acetic, formic, and acrylic acids. In the first place the glycerin of the linolein is all decomposed and carried off. Then the glycerin of the other constituents is gradually destroyed, so that at the end of three months not a trace of it is to be found. When this stage of the drying is completed, there remain linoxyn and palmitic, myristic, and elaic acids, and the paint is dry and flexible and elastic. But oxydation still goes on, though very slowly, and the fatty acids disappear. Finally the linoxyn itself undergoes decay and becomes unserviceable in binding colors or in protecting the painted surface.

The albuminous or mucilaginous matter which has so long figured in the books to account for slowness in the drying of unboiled oil, Mulder has searched for carefully but in vain; and he finds that fresh oil treated by any method which should simply remove albumen or mucilage, still dries no better than before. And, after all, this inappreciable substance, if it were present, would fail to explain what it was invented to account for: since there is no known reason why a matter that helps some oils oxydize to become rancid, should hinder others from oxydizing to become dry. It is therefore high time for science to consign this nonentity to the limbo of obsolete follies.

The oxyds and acetates of lead act as driers, not by precipitating albuminous matters, but by forming a little lineolate of lead, which oxydizes readily and communicates its activity to the oil itself. The addition of some manganese salts, such as the borate, accelerates the drying, because the loosely held oxyd of manganese oxydizes in the air and awakens the activity of the surrounding oil. No metallic oxyds or salts can act as driers unless they are brought into a state to combine chemically with the oil. Thus red oxyd of iron and zinc white and oxyd of tin are entirely inert. Sulphate of zinc or sulphate of manganese may act when oxyd of lead is added to combine with the sulphuric acid and set the other oxyd free; but without such addition, they are useless; and the oxyd of lead required for the decomposition would do more good if used alone. But oil treated with any driers by mere digestion, though it may dry quickly, can never be so good as oil boiled with suitable additions; because in boiling some linoleic anhydrid is formed, which being more adhesive and elastic than linoxyn, adds much to the value of oil for paint. The author, discarding numerous nonsensical receipts which are extant, recommends for preparing a colorless drying oil, which leaves nothing to be desired, to boil common linseed oil two hours with three per cent of red lead, filter it, and expose it to sunlight in large shallow vessels, the air over it being frequently renewed.

Mulder returning at length to the problem which gave rise to the investigation, rejects oil paints as unsuitable to prevent the rusting of iron, and concludes that coal tar contains the best materials for a protecting coat.

The book contains a great deal that is new, and the author has been, to use his own expression, "Getren dem Grundsatze, welcher uns Niederländean von Jugend auf beigebracht wird, nicht so ohne Weiteres dahin zu schreiben und sicher bei Behandlung von Gegenständen die Geschichte nicht zu vergessen." Of course he does not entirely exhaust his subject, but science is greatly enriched by this work, and it constitutes a masterly contribution to the chemistry of the arts.

J. M. O.

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