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ERRATA.

Page 119, 4th l. from top, for "90° west of the Urals," *read* "90° east of the auriferous range of Australia."

P. 123, 6th l. from bottom, for "2dus," *read* "2do."

P. 218, 17th l. from bottom, for "grapes," *read* "grasses."

P. 372, 8th l. from top, for "peroxyd," *read* "protoxyd."

P. " 16th l. from bottom, for "this city," *read* "Montreal."

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[SECOND SERIES.]

ART. I.—*On a New Method of recording differences of North Polar Distance or Declination by Electro-magnetism*; by Prof. O. M. MITCHEL, Director of the Cincinnati Observatory.

I HAVE heretofore declined publishing any detailed account of the new methods of astronomical observation in use at the Cincinnati Observatory, partly because the subject was constantly developing by new experiments, and partly because at the New Haven meeting of the American Association for the Advancement of Science, this subject, at my request, was referred to a committee for examination. The report of this committee having now been made, and the whole subject having assumed (by another year's examination and experiment) a more definite and positive form, it is now proper to present some general features of this new method, some results already reached, and the probable applications which remain to be made when suitable instruments shall have been provided for the purpose.

Observers are well aware of the difference between observations for Right Ascension and Declination. In the first, the principle of *repetition* has been extensively introduced with the best results, while as to the other, reliance is mainly placed on the accuracy of a single bisection of the star observed on one declination wire. More than two years since a plan had been executed by myself, and applied to practice in the Cincinnati Observatory, by which, on the same night, during one and the same transit, a star or other heavenly body could be observed on *ten* declination wires, with all the precision due to a single observation by the old methods. More than a year has elapsed since I presented to the American Association some three thousand observations, taken in twelve nights, by the new apparatus, (a number exceeding the recorded observations of a whole year at one of the oldest European observatories,) each of these observations presenting an accuracy superior to those obtained by the old methods.

This astonishing rapidity and accuracy gave rise to a debate, and finally to the appointment of the committee above alluded to. A multitude of observations have been made during the past year, (and in accordance with the request of the chairman of this committee,) varied with a view to test in every way the powers of the new machinery. The results, as will be seen by examining the report of the committee, were entirely satisfactory.

It is proper now to state that, by the new invention, the transit instrument is converted, (at trifling expense,) into a declinometer, or instrument for measuring N. P. D., or declination. The observer is released from the necessity of reading a divided circle, and the position of his instrument at the moment his star is bisected by the declination wire, is, by a single touch, engraved on metal, and stereotyped, to be read and examined when convenience may permit. On the swiftest moving stars, *ten bisections* are readily accomplished and engraved in the space of a single minute of time, and at a maximum hour angle of only thirty seconds of time. These records are now made on a circumference whose diameter is nearly twelve feet, and finally read up by a micrometer of as great perfection as can be applied to the measurement of any minute distances. The instrument used thus far is a transit by Dollond, the property of the U. S. Coast Survey, and furnished by the Superintendent of that work. It is of old construction, about five feet focus, and although the definition of its object-glass is satisfactory, yet the optical power is low, and a bisection by it is far inferior to one made with a powerful object-glass. The new machinery attached to this transit, to convert it into a declinometer, was made in the Observatory by my assistant and myself, and is, of course, comparatively rough. The micrometer was made in this city, and although of workmanship highly creditable to the artist, yet as it is the first ever constructed on this plan, it has been found comparatively defective, and quite incapable of detecting with certainty the minute quantities which have been presented for its examination. Perhaps no micrometer has ever been submitted to such severe tests.

Thus far in the application of the new methods, my examinations have been confined to zones not exceeding twenty-five degrees in width. There is no difficulty however in extending these researches through the entire heavens and comprehending on the same night the entire sweep of the meridian from north to south.

In case a known catalogue is under review, the amount of work done during the night will depend solely on the rapidity with which the finders of the telescope can be set. If we allow for each star three minutes, (which with an assistant to set has been found sufficient,) we have without difficulty 200 observations on twenty different objects within the hour, and for a night's work of five hours, one thousand wires or observations recorded on one hundred stars or other objects. If however the work done is independent of any catalogue, and we are sweeping the heavens in zones, there is no difficulty in recording both R. A. and declination on single wires just as rapidly as the stars present themselves, even up to 300 stars per hour of time. This has actually been done. For the purpose therefore of cataloguing the heavens, the new methods offer advantages of the highest importance.

We now present some of the results tending to demonstrate the degree of precision already reached in the determination of differences of declination. As the whole subject was entirely new, no advantage could be gained from the experience of other observatories, and hence the difficulties which have been met were encountered under the most unfavorable circumstances. Having however implicit confidence in the great principles involved in the new machinery, I never doubted for a moment that the discrepancies which arose would finally be traced to mechanical defects, or to accidental and unanticipated causes.

My attention has been exclusively directed to this single point. *Within what limits of error could the new apparatus repeat its own work on different nights, on stars whose difference of declination varied from a second or two of arc up to 25° or 30°.*

To convert the records into degrees, minutes and seconds, presents no serious difficulty, and has therefore not as yet occupied my attention, further than to demonstrate with certainty its practicability.

In my very earliest observations with *ten* declination wires, more than two and a half years since, a simple inspection of the record in the shape of ten delicate wedged-shaped dots on metal, with a powerful microscope, demonstrated at once the perfection with which these records were made within the narrow space occupied by these ten dots. The wires were as nearly parallel and equidistant as we could place them. Yet the small inequalities of distance were always measured with a precision only limited by the power of bisection under the circumstances existing during the observation. When the weather was tranquil and the stars steady, the most admirably accordant results were reached: on the contrary, when the stars were dancing or ill-defined, discrepancies were recorded, doubtless due to errors of bisection. It is quite unnecessary to present the evidence of accurate movement within the above narrow limits, inasmuch as the wider range of observation will include the more restricted.

When on a comparison of the work of two different nights, the discrepancies were reduced to the fraction of a second of arc, it became manifest that the micrometer was (as built) incapable of measuring with certainty such minute quantities. I had neither time nor means to build a new and more perfect instrument, and finding the micrometer reliable for half a dozen revolutions of the micrometer screw, a method of intercomparison of the work of two different nights occurred to me, which with my defective micrometer would test in the most absolute manner the powers of the new machinery. This was as follows, viz.

The stars of the catalogue were observed during one night on the *odd wires*, 1, 3, 5, 7, and 9, leaving the spaces blank on the engraved record, which corresponded to the even wires 2, 4, 6, 8 and 10. Every thing remaining untouched, on the following clear night the same stars were observed on these even wires, and thus a decade of dots was recorded, of which five were engraved on one night, and five others on the following one.

These records thus intermingled and interlocked, were now easily read by the micrometer, and falling as they did within the limits of reliable performance of the micrometer, the capacity of the instrument to repeat itself on different nights was tested in the most absolute manner, no matter if the stars observed comprehended a zone of even 25° or 30°. It is proper to remark that in all these observations I was assisted by Mrs. Mitchel, the stars being taken by us alternately: the reading up was done principally by herself, while the duty of recording fell to me. In this way the results reached would be independent of any personal idiosyncracy, while the readings being made by one person and recorded by another, no bias could possibly be given to the person reading.

In our first experiment of interlocking observations, forty-eight hours elapsed before it became possible to remove the metal plate from the pier, during which interval of time there were constant changes in the atmosphere, with storms of rain and wind. It was therefore with no small anxiety, that on closing the observations the microscope was turned upon the decade of dots, the work of two nights at intervals of forty-eight hours. The examination was in the highest degree satisfactory. The dots were placed with a precision and beauty perfectly astonishing, and no eye, thus far with the microscope itself, has been able to mark the difference between a decade of dots struck on two different nights, and one struck all on the same night. It did not require the micrometer screw to decide the question as to whether the instrument had repeated itself on the two different nights. This was obvious from a mere inspection of the dots by the microscope. In two instances on the extreme stars there was a slight deviation from the uniformity of the placing of the dots. I suspected this to be owing to the action of the wires attached to the arm and conducting the current from the battery through the electro-magnet. Ample length was given to the wire, but there yet remained in it a sufficient stiffness to affect the place of the arm in its extreme positions, by a minute amount. This was fully demonstrated by experiment on the following night. A star was brought to bisection on a wire, and while thus located, the conducting wires were gently touched by the hand of the observer and the instrument was seen to yield to every touch. A source of error was thus detected of a minute character indeed, but of vast importance where tenths of seconds of arc were the quantities under examination. The admirable agreement now found to exist uniformly between the work of different nights encouraged me to go back and remeasure with greater care the old work still remaining engraved on the plate. By using a mean of two or three measures the observations were brought to the most surprising coincidence. I did not attempt a remeasure of all the observations, but contented myself with a rigid examination of a single pair of N. A. stars, among whose observed differences of declination average discrepancies existed. I copy the final results, remarking simply that the observations were made between the 26th May and the 30th June inclusive.

The following are the decimals of a revolution of the micrometer screw in the ten observations.

							Second of arc.
α Coronæ to ε	Bootis	·6836	Diff. from	mean	·0017	=	0″·068
"	"	·6609	"	"	·0210		0 ·840
"	"	·6891	"	"	·0072		0 ·286
"	"	·6883	"	"	·0064		0 ·256
"	"	·6906	"	"	·0085		0 ·340
"	"	·6757	"	"	·0052		0 ·208
"	"	·6699	"	"	·0120		0 ·480
"	"	·6886	"	"	·0067		0 ·268
"	"	·6905	"	"	·0086		0 ·344
"	"	·6784	"	"	·0054		0 ·220
	Mean	·6819					0 ·340
					Prob. error,		0″·250

α Cor. to ε	Bootis,	Greenwich Obs., 1840,	0″·05	
"	"	"	1 ·61	
"	"	"	1 ·64	
"	"	"	1 ·02	
"	"	"	1 ·25	
"	"	"	2 ·67	
"	"	"	1 ·39	
"	"	"	0 ·81	
"	"	"	2 ·05	
"	"	"	2 ·52	
			1 ·401	Prob. error, 1″·3.

I shall now present a few measures of the sun's diameter, in which it must be observed that only relative quantities are obtained. Taking the N. A. as accurate on any one day of those indicated in the observations, we found the power of the new apparatus to trace the apparent changes in the sun's diameter. This is not yet absolute work.

Observations of the ⊙ Diam. Cin. Obs. Sept., 1850.

	Obs.	Comp.	Diff.
Sept. 3,	1906·68	1906·40	+0·28
4,	1907·40	1906·80	+0·60
5,	1906·82	1907·40	−0·58
6,	1907·62	1907·80	−0·18
7,	1906·73	1908·40	−1·67
9,	1910·74	1909·40	+1·34
12,	1911·58	1910·80	+0·78
13,	1910·17	1911·40	−1·23
16,	1912·44	1913·00	−0·56
17,	1912·65	1913·40	−0·75
19,	1914·74	1914·60	+0·14
20,	1916·00	1915·20	+0·80
21,	1916·62	1915·60	+1·02
1851.			
May 15,	1900·10	1900·02	+0·08
22,	1897·80	1897·60	+0·20
24,	1897·46	1896·80	−0·66
26,	1896·07	1896·20	−0·13

The work in 1850 was measured with the defective micrometer, and I attribute the increased discrepancies to this cause, rather than to any inaccuracy in the observations or records.

On the application of the principle already explained, of intermingling the observations of two different nights, most of the large discrepancies which had for a long time annoyed me, and which I felt were due to imperfections in the micrometer (but which I had not hitherto been able to demonstrate) all disappeared, and the results have since exhibited the most surprising harmony. I shall present only a few specimens of the work done, as a more full and elaborate report will be made hereafter.

Observations of June 16th and 17th, 1851.

			16th.	17th.	Diff.	Seconds.
Observer, M.	ε Bootis to	B. A. C. 4969 L.	6060	6064	0004	0″·016
	"	L. α Coronæ	6508	6420	0088	0 ·352
	"	M. 4706	3397	3288	0109	0 ·336
	"	M. α Bootis	8877	8687	0190	0 ·760
	"	M. 4933	8882	8663	0199	0 ·796
	"	L. 5120	1430	1268	0162	0 ·648
	"	L. α Serp.	2245	2252	0007	0 ·028
						0 ·418

	16th.	17th.	Diff.	Seconds.
M. ε Bootis to 4969 L.	·6060	·6064	0004	0″·016
4969 " α Cor. L.	·0448	·0351	0097	0 ·338
α Cor. " 4706 M.	·6889	·6873	0016	0 ·064
4706 " α Bootis M.	·5480	·5399	0081	0 ·324
α Bootis " 4933 L.	·0051	·9946	0095	0 ·380
4933 " 5120 L.	·2553	·2605	0052	0 ·208
5120 " α Serp. M.	·0815	·0992	0177	0 ·738
				0 ·302

I present one more specimen of the same kind of work, with some slight additional security for accuracy, simply remarking that here again the stars were observed by L. and M. without any specific order.

			Diff.	Seconds.
B. A. C. No. 6084, to 6323	5820	5896	0076	0″·304
" " ε Bootis	1335	1319	0016	0 ·064
" " α Coronæ	1407	1399	0008	0 ·032
" " 6657	1662	1662	0000	0 ·000
" " 6106	6430	6614	0234	0 ·936
" " 6589	7340	7380	0040	0 ·160
" " α Bootis	1530	1670	0140	0 ·540
" " 6110	1669	1699	0030	0 ·120
" " α Herculis	9980	0046	0066	0 ·264
" " α Serpentis	0540	0576	0036	0 ·140
				10)2 ·560
				2)0 ·256
				0 ·1280

Here it will be seen there is no accumulation of error due to the increased distance between the stars observed. This will also become more evident by examining the observations of intervals between wide stars on the preceding nights already reported.

I am now satisfied that the errors which yet remain, may be diminished one-half by the use of ten instead of five declination wires—and finally, that all work for difference of declination between stars may be accomplished with an accuracy equal to the best micrometer work, when the stars are but a few seconds apart.

The best work done in the world, (so far as I know,) has been accomplished in the Imperial Russian Observatory at Pulkova, and is reported by M. Struve in his great work on that institution. By the greatest refinement of art and skill on a few stars, the accordance between the determinations of different nights has been brought to within a limit of probable error of two-tenths of one second of arc. It will be seen by examining the results reported, that the new method, in the very infancy of its application, with defective instruments, low optical power, and with every possible disadvantage to contend with, has already rivalled in accuracy the best work ever done. Indeed the last work reported greatly surpasses the Pulkova work in accuracy, as the average error on ten differences of declination amounts to no more than twenty-five hundredths of one second of arc, while the average error in the Pulkova observations amounts (on differences of declination) to forty hundredths of one second of arc.

But the old methods have already been pushed to their ultimate limit of attainable precision. Of this, I think any one will be convinced who will read M. Struve's admirable History of the Pulkova Observatory and its instruments. On the contrary, in the new method almost nothing has been done. Any one who has used telescopes of low power and those of great power, need not be reminded of the extraordinary advantage which high optical power and good definition gives in bisecting a star.

In the great refractor of the Cincinnati Observatory, ε Bootis is divided into two beautiful stars some two seconds of arc asunder, each round and sharp, while in the small instrument used in the foregoing observations the same star appears as a single object, a large mass of light. In case it were possible to employ the optical power of the great refractor, the most astonishing increase of accuracy might be anticipated. If such an object glass were mounted as a transit, the records would then be made very conveniently on the circumference of a circle thirty feet in diameter, and a second of arc would occupy a space nearly three fold greater than that now in use by me, and fourfold greater than is elsewhere employed (so far as I know) in the world. Again, thus far it must be remembered that the preceding results are the means of *five wire observations.* There is no difficulty in increasing the number of wires to ten or even to fifteen, should it be desirable. In short, the new method is capable of almost indefinite expansion and increased accuracy—1. By increase of optical power. 2. By perfecting the mechanical arrangements. 3. By increasing the radius of the recording circle. 4. By increasing the number of observations, or the number of declination wires.

The new method also involves a principle of wonderful value in the delicate work to which it must be applied—I mean the power of stereotyping the positions of the instrument, so that the observations may be scrutinized at leisure and be read and re-read until the error of reading up shall be reduced to an insensible quantity; this cannot be done in any other method.

What then may we not anticipate from the application of this new machinery under favorable circumstances to the examination of the heavens. If Struve dared pronounce his instrument competent to the determination of parallax, proper motion, &c., with results discrepant to two-tenths of one second, then indeed has the new machinery converted a small inferior transit into an instrument competent to cope with these grand mechanical questions.

Apply it then to instruments of perfect construction, of high optical power, with equal advantages of high mechanical perfection, with a full ten wire diaphragm, interlock the observations until the power of the micrometer is fully and positively determined, and then who will dare to anticipate the results which may be reached by such a combination of science and mechanical power. Motions which have hitherto required centuries for their detection and measurement, variations in the proper motions of the fixed stars, which have only been suspected, parallax annual and systematic, even the positions of the double stars themselves, may not all these, to say nothing of aberration, nutation, precession, fall fully within the range of rapid and positive research.

With the delicate and powerful machinery for determining R. A., on which no less than twenty-five wires are successfully employed, combined with this no less powerful means of measuring difference of declination, may we not hope that even in the lifetime of a single observer some of the dark problems of the heavens which now defy our utmost efforts, may be resolved and yield up their long and deeply concealed mysteries. My only regret is that I do not possess the means to execute an immediate application of these new methods to the resolution of these high and profound problems.

Art. II.—*On the Distribution of Manganese; on the Existence of Organic Matter in Stalactites forming Crystallized and Amorphous Crenate of Lime; and on the Origin of Stratification;* by David A. Wells, Cambridge, Mass.

1. *On the Distribution of Manganese.*

The occurrence of pebbles and water-worn stones in many of the streams and water-courses of New England, which have their origin among, and run over, igneous and metamorphic rocks, is by no means uncommon, and has doubtless attracted the attention of every observer. When the bed of a stream in which they occur is examined, the colored pebbles and stones will be found at intervals, generally after or below a fall or rapid, and not immediately above. This coloring matter which is wholly superficial, and of different degrees of lustre, is due to an incrustation of the black oxyd of manganese, and occurs independently on almost every variety of stone.

In the Edinburgh new Philosophical Journal for July, 1851, Dr. John Davy calls attention to somewhat similar incrustations in England, of which he says as follows; "Though always superficial, in one spot the incrustation is so thick as to be available for use; and in this instance the black oxyd of manganese acts as a cement, forming a bed of conglomerate several feet thick. Whence this incrustation is derived, or how produced, is not obvious. Restricting the view to the spots where it occurs, it might be supposed to be a deposit from running water. But when it is seen that the coloring matter is not to be detected on rocks *in situ*, the fixed rocks in the course of the stream, the idea ceases to be tenable, and the inference seems to be unavoidable, that the sand, pebbles and stones so colored have been incrusted with the oxyd before they had been carried down to the spot where they are found loose, or when in the form of conglomerate, that the cementing oxyd has been brought by water exuding from some rock or stratum containing manganese in a minor degree of oxydation, and acquiring the higher degree by the absorption of oxygen and at the same time the cementing quality." Dr. Davy also infers that manganese exists in the vicinity of these incrustations in large quantities, and advises special inquiry in search of it.

Before the publication of the article referred to, by Dr. Davy, the subject of these incrustations had attracted the attention of Dr. A. A. Hayes of Boston, and myself, and we believe the following to be a full and satisfactory account of the origin of this phenomenon.

The manganese exists in almost all the igneous and metamorphic rocks of New England, and I may say in other parts of the world, generally as a double carbonate of lime and manganese. When the waters of the springs, brooks and rivers flowing over these rocks, become charged with soluble organic matter, in the state of crenic, apocrenic, or humic acids, drained into them in consequence of rains or inundations, from swamps and peat-meadows, the carbonates of lime and manganese enter into solution. At such times manganese may generally be detected in these waters, as has been done by Drs. C. T. Jackson, A. A. Hayes, and others. When the water holding the manganese in solution becomes broken and thrown up in the passage of falls or rapids, consequently exposing it to the influence of the atmosphere, the manganese passes from a low state of oxydation, to the insoluble peroxyd, and is deposited for a considerable extent upon the rocks and pebbles below. It will thus be found upon examination, that at intervals in the bed of the stream, the stones are completely blackened or discolored, while in other places no such depositions exist. Beautiful examples of this phenomenon may be seen at some points on the Merrimac river, and indeed in almost every rivulet in New England.

I have also noticed similar depositions between the divisional strata planes of sandstones in the valley of the Connecticut, thus showing that apparently the same agencies were at work during the deposition of these rocks as at the present day.

As an example of the extent to which manganese exists in some of the older rocks of New England, I submit an analysis of an altered rock, occurring somewhat extensively in the neighborhood of Nahant. The analysis was made at my request by Mr. John Hague of the Cambridge Laboratory, and afterwards verified by Mr. Joseph Ela.

$Si\,O^3$,	52·17
$Fe^2\,O^3$,	9·78
$Mn^2\,O^3$,	26·72
$Al^2\,O^3$,	8·43
$Ca\,O$,	0·37
$Mg\,O$,	0·60
HO,	2·02
Total,	100·09

2. *On the existence of Organic Matter in Stalactites and Stalagmites, forming Crystallized and Amorphous Crenate of Lime.*

In the eighth chapter of Liebig's Agricultural Chemistry, edited by Playfair, there is given the result of some examinations of stalactites from caverns in Germany, and from the vaults of old castles upon the Rhine, made with the view of ascertaining the fact of the presence, or absence of organic matter in these bodies, either combined or uncombined.

The result may be stated in the words of the author, Prof. Liebig. The stalactites from the caverns "contain no trace of vegetable matter, and no humic acid, and may be heated to redness without becoming black." In the stalactites from the vaults and cellars of old castles, he says, "we could not detect the smallest traces" of humic acid. "There could scarcely be found a more clear and convincing proof of the absence of the humic acid of chemists in common vegetable mould." Under the term humic acid, Prof. Liebig undoubtedly means to include all those organic acids arising from the decomposition of vegetable matter, and which have received the names of crenic, apocrenic, geic and humic acids.

Having been informed by Dr. A. A. Hayes of Boston, that he had in numerous examinations arrived at results directly opposed to those of Prof. Liebig, I was induced at his suggestion to make an examination of a large number of stalactites and stalagmites obtained from various localities, with reference solely to the presence or absence of organic matter in these bodies.

The specimens examined were all from caverns, or rock formations, and were obtained from various parts of the United States; from Trieste in Austria, Malta, and the Sandwich Islands. In color they varied from an almost pure white, to red, yellow and brown of different shades; and in crystalline character, from a structure resembling arragonite, to a variety entirely wanting in symmetrical arrangement, or a mere incrustation. The specimens were dissolved in dilute hydrochloric acid, the flocculent matter separated, collected and washed, boiled in caustic potassa, carbonate of ammonia or carbonate of soda, and then tested in the usual way for crenic and apocrenic acids by acetate of copper and carbonate of ammonia. In all the varieties, with one exception, abundant flocculent organic matter was separated, which on testing gave evidence of crenic acid in considerable quantities, with doubtful traces of apocrenic acid. The exception alluded to was the specimen examined from Trieste, which did not afford any apprec able flocculent matter on dissolving in acid. The greatest quantity of organic matter was found in stalactites of a deep yellow color, highly crystalline and uniform in character, and in the portions examined perfectly homogeneous and free from layers, or intervening bands indicating different periods and changes in deposition. As the presence of iron could not be found in the acid solution, it is inferred that the color of these yellow stalactites must be owing in great part to combined organic matter, existing as crenate of lime. In specimens like the spar ornaments from the Rock of Gibraltar, with which all are familiar, the coloring and delicate shading is also probably due to organic matter.

Dr. Hayes informs me that he has also found organic matter in arragonite in sufficient quantity to separate in flakes, while the specimen was dissolving in acid.

From these statements it must, I think, be inferred, contrary to the view of Liebig, that organic matter does exist in stalactites generally, as an acid combined with the lime, and imparting to them their various colors. I would by no means call in question the accuracy of the experiments of Prof. Liebig, further than that as far as my observations extend, crenic acid in the presence of lime, and combined with it passes over like oxalates, upon heating, into carbonates, without perceptible blackening.

It may here be added that Prof. Johnston of England, describes a compound of alumina with crenic acid, occurring in caves of granite upon the coast of Cornwall. This mineral has received the name of Pigotite, and is observed in places where the surface water trickles down over the granite rocks. From this it may not be inappropriate to apply the term *crenite* to those lime formations in which crenic acid occurs in considerable quantities.

Results similar to those announced above, have been obtained by Dr. C. T. Jackson, as well as by Dr. Hayes of Boston. Dr. J. Lawrence Smith informs me that he has frequently met with crenic acid in lime concretions from Asia Minor, and its existence in stalactites was also announced by Dr. Emmons of Albany, some years since. My results can therefore be considered but as the verification of those obtained by others.

3. *Observations on the Origin of Stratification.*

The general idea respecting the origin or cause of stratification, as expressed in geological text-books, or as inferred from the writings of geologists, seems to be this; that strata or the divisions of sedimentary matter have been produced either by an interruption of deposition, or a change in the quality of the material deposited. This idea is well illustrated by the deposition of matter of tides or inundations, its subsequent consolidation, and a renewed deposition on the plane of the former deposit. That such is really the cause of stratification in very many or most instances, I do not dispute; but that there are other causes which tend to produce and have produced stratification equally extensive and varied, is, I think, clearly shown by the following observations.

My attention was first drawn to the subject during the past summer, while engaged in the analysis of soils. By the process adopted, the soil was washed upon a filter for a considerable number of days, in some cases for a period as long as two weeks, and subsequently dried at a temperature of 250° Fah. The residue of the soil left upon the filter, consisting chiefly of silica and alumina, was found after drying, in every instance to be more or less stratified, and that too by divisional planes in some cases not at all coincident with any division of the materials, although this is apt to take place. The strata so produced were in some instances exceedingly perfect and beautiful, not altogether horizontal, but slightly curved, and in some degree conforming to the shape of the funnel. The production of laminæ were also noticed, especially by the cleavage of the strata produced into thin, delicate, parallel plates, when moistened with water.* These arrangements, it is evident, were not caused by any interruption or renewal of the matter deposited, or by any change in the quality of the particles deposited, but from two other causes entirely distinct, and which I conceive to be these; first, from a tendency in earthy matter, subjected to the filtering, soaking and washing of water for a considerable period, to arrange itself according to its degree of fineness, or perhaps according to the specific gravity of the particles, and thus form strata; and secondly, from a tendency in earthy matter, consolidated both by water and subsequent exsiccation, to divide independently of the fineness or quality of its component particles into strata or laminæ. The tendency of this earthy matter is generally to divide on drying along the lines formed by the arrangement of the particles according to their nature or quality. This is not, however, always the case, as was proved by the observations noted, and which is also conclusively shown by the examination of almost any stratified rocks. At the clay slate quarries near Charlestown, Mass.,

* The laminæ so produced were not always parallel to the strata divisions, although parallel to themselves.

the lines formed by differences in the quality of the component particles is beautifully marked on almost every slab, yet the divisions into layers are not coincident, and there is not a tendency to divide along the lines of arrangement.

At some points in the valley of the Connecticut where the sandstones remain unaltered in any great degree by heat or dislocation, the stratification produced by these several causes may be clearly seen and studied. On the western edge of this deposit, opposite Springfield, we have rocks composed of layers which would at once be referred to the production of tides or inundations by the most inexperienced observer. The strata here vary from the fraction of an inch to an inch in thickness; they are also covered with mud-cracks, and the various markings which are usually found upon a shore or beach. In other portions of the valley we have strata divisions, occasioned by the lines which separate materials differing either in quality or nature; as the shales from the sandstones, the conglomerates from the fine sandstones, or the highly bituminous shales from those less bituminous. And then upon the extreme eastern edge of this sandstone deposit we find strata, the leaves of which measure from one to two, and some instances three feet in thickness, some layers embracing in themselves matter ranging from a coarse conglomerate to the finest sand; and yet none of this collection of materials, within the limits of the particular layers in which they are included, exhibits the slightest tendency to break or divide in any one direction more than another.

The observations here stated, I am happy to find have been also noticed to some extent by others conversant with the subject of stratification. Sawdust subjected to the filtering action of water, has been observed by Prof. Agassiz to assume a regular stratified appearance. The same has also been noticed by Dr. Hayes of Boston, in the vats in which clay used for the manufacture of alum is washed. Dr. Emmons of Albany has referred me to an instance of a clay bed in which the strata of one portion are distorted and inclined, apparently from a force acting laterally or from below, but which force evidently could not have so acted from the perfectly regular and undisturbed condition of the surrounding clay strata; the inclinations must, therefore, according to Dr. Emmons, be referred to a peculiarity of deposition or a subsequent division at an angle on consolidation. I have also noticed regular stratification in the dried deposit of a puddle in the streets, where no apparent change in the character of the materials deposited could be noticed, and where there was certainly no interruption of deposition.

If the divisions of stratification or lamination which I have thus pointed out be admitted, it is not improbable that many cases of what are now considered disturbed and tilted strata, are in none other than their normal condition.

ART. III.—*Instructions for making wet Preparations of Animal Substances;* by HENRY GOADBY, M.D., F.L.S., formerly Dissector of Minute Anatomy to the Royal College of Surgeons of England.

IT frequently happens to the naturalist, and the microscopic observer, to meet with animals, or tissues, which, from a variety of circumstances, cannot be retained in any other form than that of a *permanent preparation*. They may be small, and so delicate, that they would be entirely lost if put into a bottle; and in such a case, it is desirable to mount them, without delay, as preparations for the microscope.

If the object be merely a filmy tissue, take a piece of glass of good quality, good surface, and flat; the substance is not material.* Clean it with liquor potassæ or dilute sulphuric acid, or use both these fluids, mixing them on the glass; they effervesce, decompose each other, and at that moment, clean the glass; rinse it in clean soft water and dry it with either a clean muslin handkerchief, or a piece of chamois leather; now test it with a drop of water placed on the center of one side of the glass, and if the water can diffuse itself *evenly over the whole surface, the glass is clean;* if not, it must be made so.†

This, which is frequently the most difficult part of the whole process, being accomplished, place the glass in the vessel in which the tissue to be mounted lies in preserving fluid, and float it on to the glass; withdraw the latter carefully from the vessel. With a fine (needle) point adjust the tissue to the center of the glass, and soak up the excess of fluid with a camel's hair pencil, leaving enough to cover the preparation. Now take a piece of *thin* glass, such as is used by microscopists, previously cut of less width than the slide or glass on which the tissue lies, and having cleaned it by the mode described, hold it at one end by a pair of finely pointed forceps, and apply the other extremity, holding it almost vertically, to such portion of the other glass as to leave the preparation in the center of both.

Gradually lower the top glass, and the fluid will run before it until the preparation be covered, and the top glass finally rest upon the lower one.

A quantity of fluid will yet remain outside the top glass which must be carefully taken up with the camel's hair pencil until the

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* The best glass for this purpose is the "patent British plate," manufactured by Messrs. Chance at Birmingham.

† It sometimes happens that neither acid, nor potash can clean a piece of glass sufficiently well to enable it to endure the test proposed; in such case a watery solution of gum arabic may be used, or, what is still better—the human saliva will clean it instantly.

surface of the lower glass, around the top one, be made quite dry, when the following cement must be applied to the clean, dry glasses, to shut in the fluid, and render the preparation permanent.

Take Egyptian asphaltum and dissolve it in camphene to the consistence of a thick paste; this process is greatly facilitated by the application of moderate heat. Keep it in a well secured vessel, and label it. Then take *japanner's gold size*, which may be obtained at the varnish makers, but generally it is too thin, because new. Inspissate it by the continued application of heat until it acquire the consistence of molasses, then with a muller, upon a marble slab, grind up with the gold-size as much lamp-black as you can, until you have formed a *very stiff paste*; this should also be well secured and labelled. The properties of these ingredients are as follows:

Asphaltum is hard and brittle.

Gold-size is highly tough, and elastic, and retains these properties for many years. By combining elements respectively *too hard*, and *too* soft, the one is made to counteract the objectionable properties of the other, and the lamp-black not only assists to give good consistence to the whole, but is desirable from its indestructibility.

Japanner's gold-size is composed of boiled linseed oil, dry red lead, litharge, copperas, gum animi, and turpentine.

To use the cement, take equal parts of each of the above materials, taking care that the gold-size composition should rather preponderate over the asphaltum, than the contrary; mix them intimately on a slab with a small palette knife; if too thick to work well, add a few drops of camphene, *but beware of making it too thin*. Apply the cement, thus made, to the outer margin of the top glass; do not use too much for the first coat, but rather by successive layers, applied at different periods, fill with cement the space between the lower and upper glasses of the preparation, until a good solid layer be formed, when the process is complete. It is, however, most important *to isolate the several layers of the "black" cement*, for the turpentine contained in a newly applied coating will act upon, and partially dissolve, the old and dry layer; in this case, the upper surface being exposed to the atmosphere will speedily *dry* and *contract*, and acting upon the softened cement below the surface, will drive it between the glasses, and spoil the preparation.

Either of the following compositions may be used for the purpose of separating the layers of the black cement.

Gum arabic, ...	3 drams.
Sugar, ...	1 do.
Corrosive sublimate, ...	1 grain.
Water, sufficient to make a thick mucilage.	

Marine glue, dissolved in an excess of white-wood naphtha, to form a thin solution of the glue. This, which is by far the best application for the purpose, dries nearly as rapidly as it can be used.

Having devoted upwards of thirty years of my life to the dissection of small animals by the aid of the microscope, and in the preparation of the elementary tissues of all animals, from man downwards, and being desirous of preserving and making permanent the results of my (frequently) very tedious labors, my wants, in this respect, were necessarily peculiar. The ordinary form of vessel, then, (and now,) in common use—a bottle, was altogether unsuited to my especial necessity; I could not place a *bottle* under the microscope for the examination of its contents, nor see the preparations without the microscope, the aberration, resulting from the figure of the bottle, precluding the possibility of defining with precision, the preparation contained within. Thus, the work I had been able to accomplish by suitable optical assistance could not be rendered apparent to my friends, by the use of a microscope; and whether it were an exposition of the nervous system, or other organic structure of an insect, or a minutely injected tissue of a frog, or a man, they were alike inaccessible to unassisted vision; moreover, to increase my difficulties they required to be kept as *wet* preparations. Having been in the constant habit of dissecting under water, in tin pans of various forms and sizes, and always covering these pans with a plate of glass to keep out dust, &c., when they contained unfinished dissections, or an animal simply prepared for dissection, I was struck with the beautiful appearance of an insect, or other entire animal, lying as naturally as possible, with all its full proportions displayed, retaining its characters in their utmost integrity, and so arranged as to be easy of access to the most superficial observer. To my vision, there could not be a more charming sight, than a finished dissection of the nervous system in situ of any insect, especially of the Blatta Americana—one of which I dissected at ten years of age—while lying in the pan in which the dissection has been performed; and sorely have I grieved at the sadly changed appearance of the same insect, at the instant I placed it in a bottle containing alcoholic fluid, ostensibly *to preserve* it, but actually to complete its disfigurement. Neither could I suspend a delicate preparation in a bottle, in such a manner as to insure its safety. With a quantity of air always contained in the bottle, *the fluid* is put in motion by the act of taking up the vessel to examine its contents, and the particles of fluid beating against a delicate tissue will inevitably in time break or displace the structure that had cost the patient labor of many tedious hours to dissect and display. Thus, by my own act, not unfrequently, and by the carelessness of others, I was continually losing my preparations; and this determined me to attempt a form of vessel that should agree, as far as possible in all general particulars, with the pans, in which, I used then, and still continue, to dissect. Believing *glass* to be the very best material for my purpose, I consulted several operative glass-grinders on the subject; who all declared the work I required could not be done, and that if it could be accomplished, the cost would prove prohibitory. Not to be diverted from my purpose, nor discouraged by the statements of the glass-grinders, I determined to try and work out my plans with my own hands, although I had not received education in any branch of mechanics. Moreover, in connection with my project as a whole, I required a good cement for the glass vessels, and some other preserving fluid than alcohol. These subjects occupied me more or less for twenty years, during which time the failures were frequently quite disheartening, chiefly as regarded the *mechanical* part. On one occasion, I possessed about three dozen of glass vessels, each full of fluid, hermetically sealed, and containing a minute dissection, which had remained permanent for a period of two years. A gas microscope had just been invented, and was then on exhibition in Bond street, London. In an evil hour I submitted my preparations to this instrument; the intense heat of the gases melted my cement, and all my treasured dissections were destroyed before my face—this occurred about eighteen years ago. In the years 1839–40 and 41, I worked most perseveringly at my glass cells, and vessels, with a view, either to complete the plan, or to give it up: at the latter end of '41 I possessed a large collection of preparations all of them contained in vessels similar to those I now use and intend to describe. I submitted them to the inspection of the Society of Arts who, having invited the assistance of a large number of eminent men, awarded me their large gold medal "for his method of putting up anatomical preparations." The medal was awarded in November, '41, and presented on the distribution day in '42.* I have felt it necessary in my own justification, to give this history of a plan of mounting zoological or anatomical preparations, now in very extensive use, as I observe the method is recommended and explained in a recent publication without giving me the credit of originating and perfecting it.

There are many objects for the microscope, of great zoological or physiological interest, which possess more substance than will allow of their being treated in the way already described, although their characters can be preserved only as *wet* prepara-

* The preparations here alluded to were subsequently purchased from me for £500 sterling, or \$2500, by a private subscription, headed by H. R. H. Prince Albert, and presented by the subscribers to the Hunterian Collection, in the Royal College of Surgeons, where they now remain.

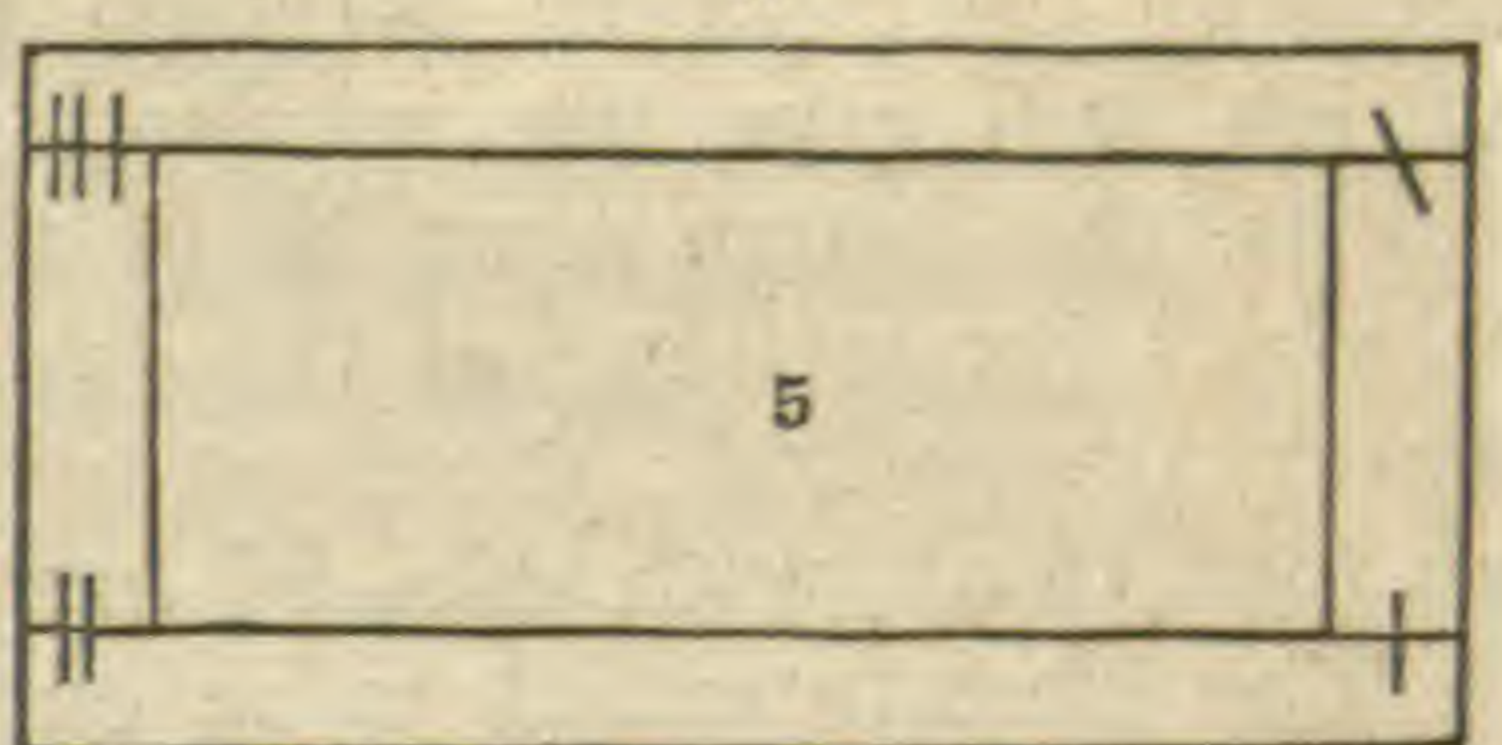
They were also rewarded by the late Sir Robert Peel, at that time First Lord of the Treasury, who presented me with a check, on the Royal bounty fund, for £150—\$750.

tions; for all such, a *cell*, or a glass box, must now be prepared, and the following is the way to proceed.

First, accurately measure the length, breadth, and substance of the preparation to be mounted; select a piece of flat glass of substance agreeing as nearly as possible with the thickness of the preparation and with a glazier's diamond cut off two pieces from one-eighth to three-sixteenths of an inch wide, and of equal length; these are to form the sides of the cell; the ends must be of the same width but not so long. Although the cell should *fit* the preparation in regard to *depth* or thickness, a good space should always be allowed around the sides and ends, for example: I desire to make a cell for a preparation measuring one inch long, and five-eighths wide, I should make the cell one and a half inch long, and one inch wide, *inside* measure, when finished the preparation looks better, is more accessible to the microscope because the sides of the vessel are not in the way, and, what is most important *there is more room for preserving fluid* than if the vessel be contracted to the actual size, or thereabouts of its contents. The *depth* should be exact for two reasons: one, that thereby the object is retained in the center of the cell, being lightly pressed upon by the top, and bottom glasses; the other, that there being no greater substance of fluid between the object and the microscope than must needs be, a better definition of the object is obtained.

When glass is cut with a diamond it always leaves a rugged, uneven surface; for example, when broken off, one piece of glass will present a series of projections, which have left corresponding cavities in the piece to which it was attached; when placed together, they lock into each other and the addition of a thin layer of cement will form a perfect joint.

1.



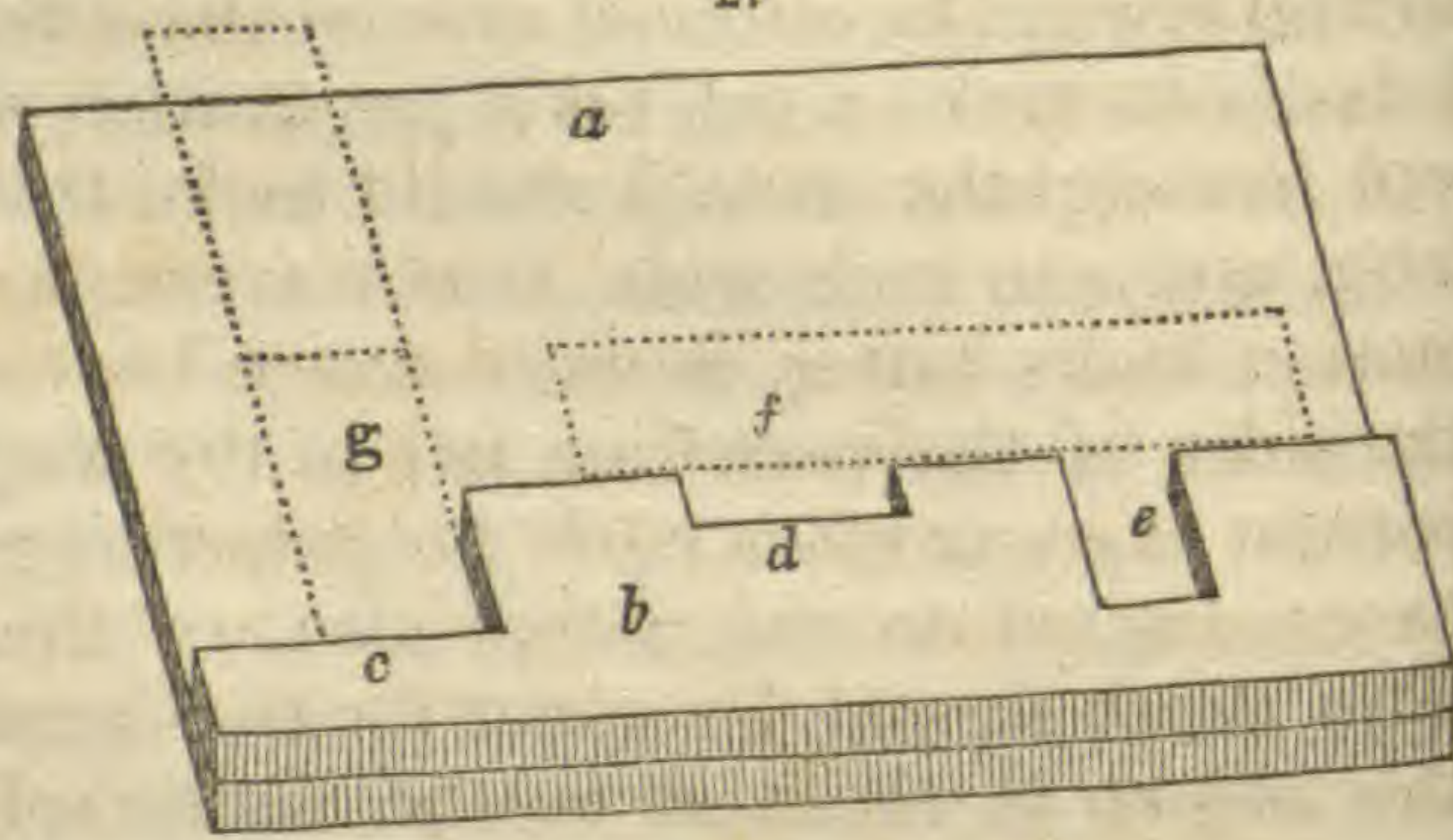
I avail myself of this fact in constructing cells of the kind just described, thus: fig. 1 represents a piece of glass of the exact length and breadth, *outside measure*, that the cell is required to be.

The two long pieces, or sides, are first cut, and before breaking them off they are marked with the scratch diamond so as to include the ends. As the width of the cell is not always sufficient to admit a number of lines, I first make a diagonal mark, then 1 and 2—rarely 3, which is unnecessary. I now separate the pieces, discard number 5, and take care to cement them to the bottom glass or slide, in the order in which they are marked, and to ensure accuracy in this respect, keep the marked surface upward. As it is necessary to have a bottom glass before we can cement the pieces just cut and marked, I proceed to give some

Description of the Slides.

My peculiar wants have necessitated slides of larger size than that proposed for general adoption by the Microscopical Society of London; moreover, I had a collection of uniform preparations on slides of my size, long before that Society had existence. The slide I chiefly use measures when cut $3\frac{3}{4}$ inches, by $1\frac{5}{8}$ths: the glass should be the "patent British plate," before referred to, which being ground and polished on both sides is generally very flat: its substance varies from less than $\frac{1}{16}$th to $\frac{1}{8}$th of an inch.

2.



CUTTING BOARD.

Cutting Board.—To cut the slides expeditiously and uniformly it is necessary to have a *cutting board*, fig. 2.* It consists of a mahogany board 11 inches by $9\frac{1}{2}$, half an inch thick and rectangular in shape; on one of its long sides, *a*, is fastened by means of pegs or screws and glue another piece of mahogany, the *guide board, b*, $2\frac{1}{2}$ inches wide and $\frac{1}{4}$ thick; this must be planed so as to be true, as the front is to form a *straight edge.* By reference to the figure it will be seen that spaces have been cut out of the guide board, the use of which will presently appear. A flat rule or gauge should be made of mahogany, 11 inches long and $\frac{1}{4}$ thick, the width to be ascertained as follows: mark out in card board a pattern of the slide intended to be used, apply the glazier's diamond to a line indicating one side of the pattern and accurately measure the distance between the diamond and the other side, which will give the required width of the gauge. In other words, the gauge must be of the width of the pattern, less *the* "*rake*," (or setting) of the diamond. In addition to gauges, a *square* is essential; the most useful is of mahogany, one-fourth of an inch thick, with sides $6\frac{1}{2}$ inches long and solid, i. e., not open.

The glass intended to be cut into slides should be placed on the cutting board, and if none of its sides have a true edge, a narrow slip must be cut off its entire length to form one. The straight side of the glass must now be brought against the guide board to ascertain if either of the sides, at right angles to the cut side be perfectly square with it; if not, it is only necessary to square one side: for this purpose place the side to be squared so that it project a little beyond that part of the guide board which is cut away at *g*, apply the square, and cut off a narrow

* This figure should be reversed throughout to give correctly the form adopted.

slip in a direction contrary to the former cut: thus the two sides of the glass are made true.

Keep the glass still against the guide board and removing the square, apply the *gauge;* cut the whole length of the glass and you have the width of the slides. Now turn the squared end of the glass just cut into the space at *g*, pressing it firmly against the angles of the guide board, (which must also be made quite true,) place the gauge against the guide board in its former position, cut the glass transversely, as shown by the dotted line, and you have the length of the slide; and in this way cut up the remainder of the slip of glass as far as it will yield slides of the proper length.

In like manner the spaces *d* and *e*, in the guide board, give the length of other slides, the width of which has been cut previously with other gauges adapted to the purpose. By this arrangement of the cutting board one gauge is alone required to cut the width and length of a slide of any given dimensions. From the foregoing description it will be obvious that the gauges must be first made, the length of the spaces in the guide board determined by their assistance, and they must be cut in it before it be affixed to the cutting board.

Grinding the Glass.—Unless the slides are to be covered with paper, the sharp, rough edges left by the diamond cut should be removed by *grinding the glass.* This can be accomplished on a perfectly flat stone of sharp grit with water; the process is greatly facilitated by the addition of emery, but the best tool, in my experience, is a plate of *soft pewter.*

My plate was formed in a mould made for casting the pewter plates on which to engrave music; its outside measure, therefore, corresponds to the size of a printed page of music, but it is ½ an inch thick, and weighs 14 lbs. It is important that the surfaces be made quite flat, and every care should be taken to keep them so. *Soft* pewter is desirable because it contains a much greater quantity of lead than the hard, in which tin preponderates. The metal is used only as the vehicle of the cutting material, which is emery. The latter, in time, becomes thoroughly impacted in the metal, so that it will cut with the assistance of water alone, and the wear of the plate is too trifling to be estimated. When in use it should always be charged well with "superfine" emery, and water. Finer emery has no cut; and coarser tears the glass.

Hold the glass slide to be ground at an angle of about 45°, that *the outer line of the edge* may alone touch the plate of metal; grind by a quick, light, circular motion—to and from, rounds the corners—until the line be straight and beveled; change the position of the glass to grind the *opposite* outer line in the same manner; now hold the glass vertically, and make the edge smooth. By beveling the outsides of the edge of glass in the first instance they are saved from breaking, which is inevitable without this precaution; it is true that beveling can be done at any time, but it is not easy to grind out the deep irregular holes caused by splitting the edge. In this way, the four sides of the slide are to be ground.

To keep the pewter plate flat, grinding should invariably be conducted all over its surface; but as this is somewhat difficult with small pieces of glass on a large surface of metal, I devote one side of my plate for slides alone, and reserve the other for purposes where the utmost flatness is necessary. Its flatness, however, should be frequently tested with a straight edge, and if elevations appear, they should be reduced by grinding them down. Optical glass grinders and other mechanics, who require a plane grinding surface, have three similar tools; when one of them becomes untrue by use, it is ground with one of the others, until they present a like surface, neither of them being true. Tool No. 1 being now ground with tool No. 3, the inequalities left by No. 2 are obliterated, and a flat surface is the result. As it would be particularly inconvenient for me to carry with me three plates each weighing 14 lbs. for the sake of keeping one of them true, I resort to another, but equally efficient plan: I take a piece of plate glass of the same length as the pewter plate, the width not being very material, with plenty of emery and water I grind the metal all over its surface with the *flat* side of the glass until they present a corresponding surface; if the metal be not sufficiently flat, I turn the glass and grind the other side: by this process the flatness of the metal may be insured.

To abbreviate the time of edging the slides, it is expedient to hold one in each hand and grind them simultaneously; and although this may be somewhat difficult at first, a little practice will give all the facility and tact necessary for thus grinding *two* glasses in the time of one.

Cement for the Cells.—The slide being ready, the cell is to be cemented to it, and for this purpose a good, and water-proof cement is necessary. Canada balsam is too brittle; gum mastic is equally brittle and difficult to use, and I could not for some years find anything equal in toughness and durability to my own composition—gold size and lamp black—and I have now in my possession cells containing wet preparations cemented with it 14 years ago, every portion of which is perfectly sound. It is, however, in every respect, vastly inferior to the marine glue already alluded to. In the year 1842 my attention was directed to this composition by the newspaper accounts of experiments made with it at the Royal dockyards at Woolwich.

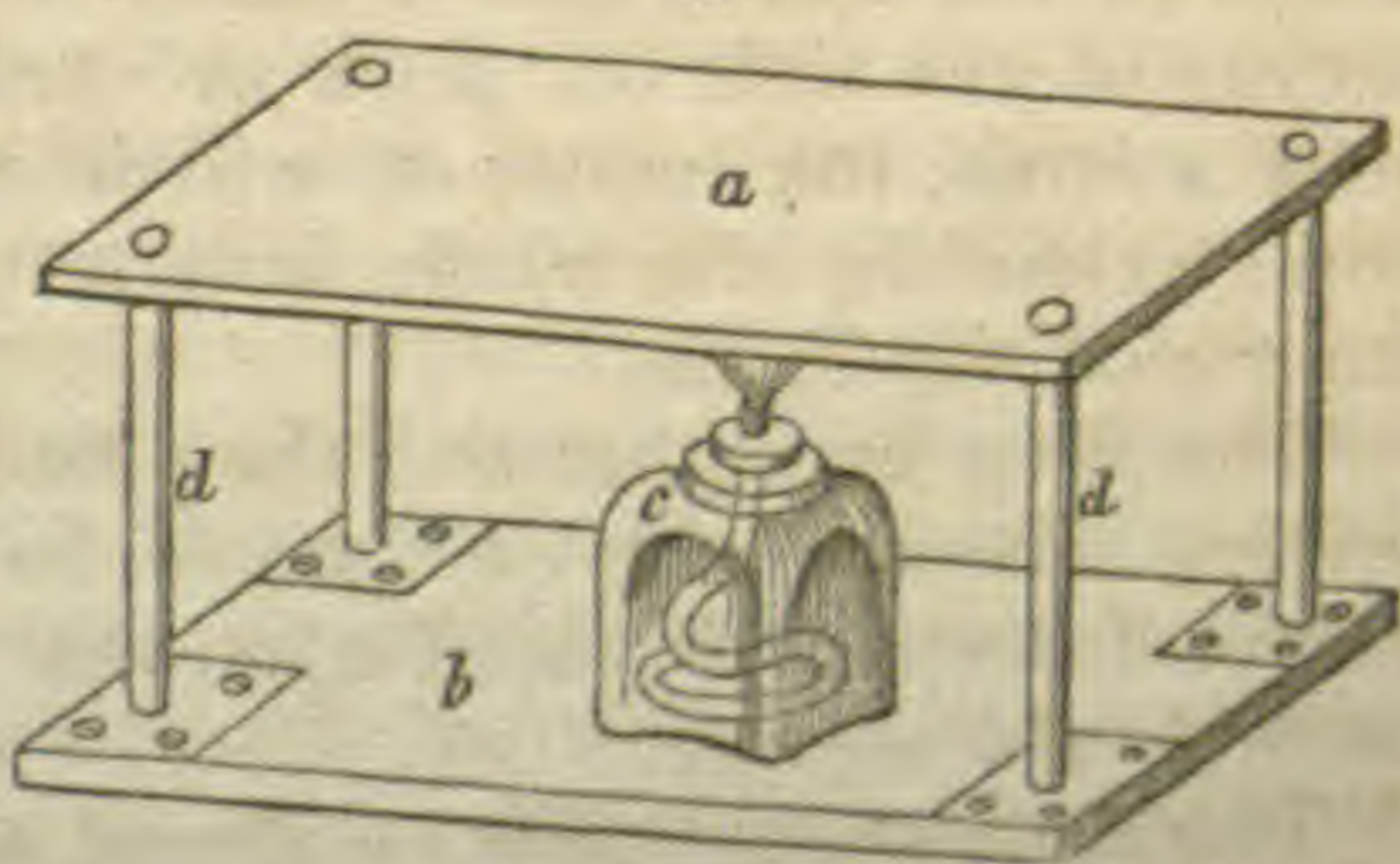
I consulted the patentee, Mr. Jeffery, and desired to know if it could be applied as a cement to glass; of this he knew nothing, but gave me some to try, and general directions how to use it. It failed; and for some months continued to fail, until the inventor made some specially for my use at the College of Surgeons, with which I had the most complete success. As made for general use the marine glue consists of different degrees of hardness, distinguished by numbers, from one, downwards; the particular composition made for me agreed nearly with the ordinary "No. 4," but as in addition to caoutchouc and shell-lac—the staple ingredients of the marine glue—this contained another and most important material, as applied to glass, it was agreed to call it "No. 4, G. K.;" subsequently the same valuable ingredient enters into the composition of every form of marine glue, so that "No. 4" is now a sufficient description of it.

Another and very beautiful preparation of the marine glue has been made in this country, suggested by Dr. P. B. Goddard of Philadelphia.

It consists of caoutchouc dissolved in chloroform by the application of gentle heat to the consistence of a thick mucilaginous paste; then add clean, carefully selected tears of gum mastic, until the composition become sufficiently liquefied to use with a brush, when it should be filtered to free it from the dirt always combined with the gums in question. The gum mastic not only readily dissolves in chloroform, but it is a somewhat curious fact that it should reduce the thick solution of India rubber to the condition of a transparent, limpid fluid; it must not be made too thin however, for when dry it will be brittle from the excess of mastic. This is a very elegant cement; it can be used with or without heat, and when dry it possesses the great advantage of being perfectly colorless and transparent: I have not employed it for vessels of much size, but simply for shallow cells. The patent marine glue requires heat, and I have already described one mode of melting it; the following is the way *to cement the cells.*

Apparatus used in cementing the Cells.—I employ for this purpose an apparatus that I made many years ago for mounting preparations in Canada balsam. It forms an important part of the contents of my "manipulating box," and it is one of the things pirated by the author of the modern work already indicated.

3.



A plate of wrought iron, $5\frac{3}{8}$ths by $2\frac{3}{8}$ths and $\frac{1}{8}$th thick, ground on its upper surface, (fig. 3, *a*,) is supported by four legs of brass wire (*d*) $\frac{3}{16}$ths diameter and 3 inches long in the clear; they screw into holes at the corners of the iron plate, and their free ends are placed in sockets in a mahogany board (*b*) the size of the iron plate, and $\frac{3}{4}$ thick. When in use, the plate becomes so hot that it cannot be touched with the hand, and the legs, by conducting the heat, mark the table; to render the entire apparatus more convenient, I found it better to add the mahogany board; the holes for the legs are defended with brass plates, and they fit *tightly* so that the whole can be moved bodily out of the operator's way. The spirit lamp (*c*) is 1¼ inch square and 2¼ high to the top of the brass wick holder —exclusive of the ground glass cap. Every part of the glass that is to be coated with the marine glue should firstly be lightly painted with the fluid solution of it before described. Thus prepared, the slide and the four pieces of the cell should be placed on the iron plate, and the heat of the lamp applied beneath.

The position of the lamp should be frequently changed, to impart an equal temperature to the iron plate, for if there be too great accumulation of heat at any one point, the glass will instantly break: should the plate become unnecessarily hot, lower the wick, or remove the lamp for a short time.

The solid glue may be cut into long thin slips with a knife or scissors, and applied to the painted surface of the slide and pieces of the cell, until the glass be hot enough to melt it, when it should be distributed evenly over the glass by means of a stouter piece of glue held in a pair of short, strong forceps. Then search, for, and remove, particles of grit and dirt which are contained more or less in the glue—they are best seen by removing the glass from the iron plate and placing it on a piece of clean, dry, white paper; they can be easily removed by the point of a knife, or a piece of the solid glue. Extraneous particles are frequently broken into fragments between the glasses by the pressure necessary to form a joint, but they should always be removed, as they act mechanically as a wedge, and preclude the possibility of a permanent joint.

At a certain temperature the glue will bubble and boil, at which point it should be removed from further contact with heat; otherwise it will be decomposed, and all its characteristics destroyed.

For neatness and uniformity, the cells should be placed in the center of the slides, and to accomplish this it is best to mark the outline of the slide on paper or card-board with a pen, and then draw a cross, the center of which is the center of the slide, its limbs extending the whole length of the long and the short diameter of the figure.

The glass being hot and the glued surfaces freed from dirt, the several pieces of the cell are to be turned quickly over with a pair of forceps and placed upon the slide in the relative position they should occupy.

The slide should now be placed on the card-board figure, each piece of the cell should be pressed down to the slide with two pieces of wood, and rubbed to and fro to express the excess of glue and make as near approach to contact with the lower glass as is compatible with the thinest layer of glue. The four pieces of the cell having been cemented to the slide and to each other, its position can be readily adjusted to the center by the aid of the cross. Should the glass become a little too cool and the glue set, replace it on the iron plate and complete the adjustment.

Before the glass and the glue become quite cold and hard, it is desirable to remove the superfluous glue which holds most pertinaceously when cold: the best form of instrument for this purpose is the lozenge-shaped tool used by engravers, keeping the point close to the sides of the joint, or a knife point may be used, taking care not to scratch the glass. As a rule, it must be borne in mind that, whenever a cell consist of more than one piece of glass, it should be ground flat on the pewter plate before it is fit to be trusted: the slightest inequality, either in the substance of the glass at one end, or in the layer of the marine glue, will prevent the possibility of making a good joint hereafter with the top glass or cover.

To clean the glass perfectly I use a small piece of cotton wool gathered into a knot, held by a pair of strong steel forceps, and a drop or two of liquor potassæ, or a saturated solution of caustic potash, which softens the marine glue and admits of its removal. Care must be taken not to allow the potash to remain in contact with the joints, as it decomposes the glue, and will render the joints unsound. The glass should be well rinsed in a large quantity of clean water to remove the potash.

A top glass or cover must now be cut for the cell, and this should be somewhat smaller than the outer diameter of the cell on all sides to allow room for the cement. The edges of the cover, and the surface of the cell should be painted with the naphtha solution of marine glue; and the cell will then be ready for the reception of the preserving fluid, and the preparation. It is best to fill the cell over some other vessel to catch the excess of fluid that is sure to run over the sides; a small, shallow dish or saucer will answer this purpose; and if the cell be supported upon a level something placed in the dish, the better, as the operator will have his hands at liberty.

Having filled the cell with fluid, take a short but strong camel's (or badger's) hair pencil and rub the fluid into the corners, along the sides of the cell, and even the bottom glass, for this reason; in pouring the fluid into the cell, it remains *separated from the glass in every direction* by a filmy layer of atmospheric air, which can only be removed, and the fluid and glass brought in contact mechanically, or by the thin gum-water, or saliva, formerly referred to. If a vessel be sealed down without attending to this precaution, the air will be liberated by degrees and form a great number of minute bubbles, glistening in rows upon the sides, in the angles of the cell, and even upon the bottom glass: —ultimately they coalesce and an air bubble of some size is the result. For the same reason, (the displacement of air,) the preparation must be placed carefully in the cell, and if it possess cavities in the under surface, they should be pressed out, if possible, while the preparation is entering the cell; and this should be managed so that one end of the preparation goes into the vessel first, and the remainder lowered gradually. A good steady stream of fluid should be poured into the cell, the preparation being held down by a camel's hair pencil or forceps, until all extraneous particles be washed away, and the fluid continue bright and clear. When at rest the fluid in the cell will present a *convex surface*, bounded on all sides by the painting of marine glue.

Now prepare one surface of the cover, either by the tongue or brushing on the fluid as before, and holding it by a pair of forceps at one end of its *longest* diameter, lower the other end to the cell, and let it down gradually—the excess of fluid running before—until it be in its place; then adjust it accurately, press down the cover till it touch evenly every part of the bed on which it is to rest, remove with a brush whatever fluid may yet remain on the outer edges, and paint them *once* more with the naphtha solution, including this time the top glass: apply the black cement, and the preparation is finished. Should another layer of black cement be required, allow the first to become quite dry, and isolate it, as before directed, with the naphtha solution: successive layers of the black cement must always be thus separated.

Drilling or cutting circular holes in glass for cells.—A more elegant mode of constructing a cell, is by drilling a circular hole through a piece of glass (fig. 4); but when I first attempted this plan, (in the years 1839–40,) the cost was prohibitory. At last I employed at the same time, three workmen in London to ascertain the lowest rate of cost at which holes of all sizes could be drilled in glass, in any quantity not less than one gross. Neither of these men employed the same means; one of them, a German, cut most beautiful cells, perfectly square inside, but he could not do them for less than 1*s*. 6*d*. or 36 cents each.

4.

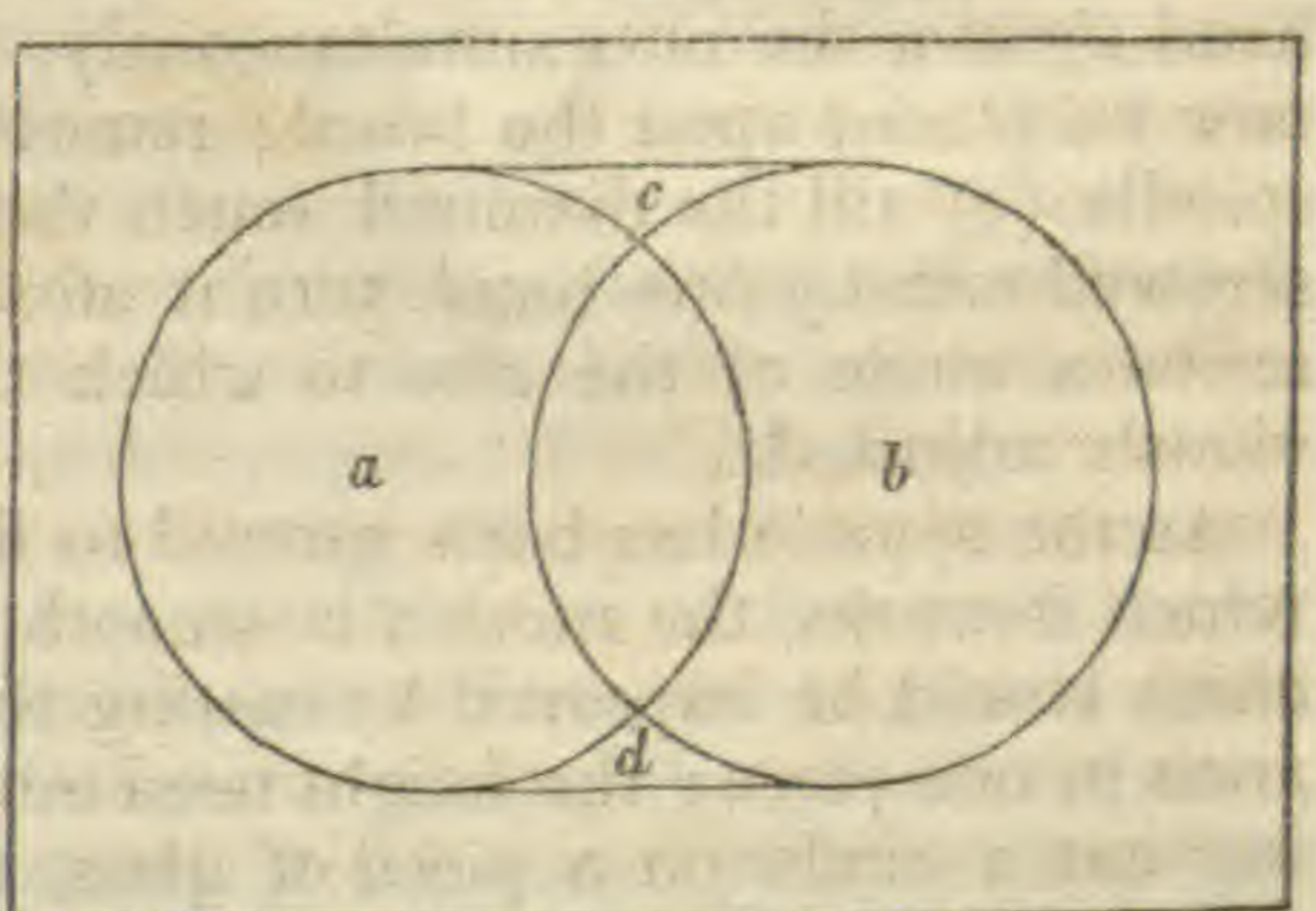
Another made very indifferent cells at 1*s*. or 24 cents each; and the third made excellent work at 6*d*. or 12 cents each. Subsequent, another man undertook to do them equally well for half that sum, and ultimately I procured them at the same price, excellently cut, from Mr. Dennis of 1 Charles street, St. John's street road, London. The following is the plan of proceeding: procure a copper tube (or drill, as it is called) of the diameter you desire your cell to be: I have long since discontinued cells of *all* sizes, and chiefly use one of $1\frac{3}{16}$ths diameter, cut out of a square of glass $1\frac{1}{2}$ inch *full*, outside measure.

With my large slides such a cell enables me to preserve great uniformity in my preparations, affords abundant space for the transmission of light around the object, holds a sufficient quantity of preserving fluid, and the squares can be cut with the same gauge used for the slides themselves. The length of the drill may be from 1 inch to $1\frac{1}{2}$ long, and made to run true in a lathe. The squares of glass being all of the same size, I cement a number of them together with the marine glue, so as to form a pile of from one inch, to two inches high.

Where a *lathe* is used, it is important to face the pile of squares with something that has been already perforated with a hole the size of the drill, to enable the latter to enter at once upon its work, and prevent the stratching (and spoiling) the first cell. For this purpose, *brass* perfectly flat, can be used; but a better thing is a square of *plate glass*, one-fourth of an inch thick, already perforated by the same drill, and this should be kept for the purpose alone.

The copper drill is to be charged with fine, sharp cutting sand and water, and the block or pile of glass squares applied to it, and gradually pressed up by the tail spindle of the lathe, while the drill should revolve at a *moderate*, but not a *rapid* rate. When a number of cells are drilled, they can be easily separated from the block by placing the outer cell downwards on the iron plate and applying the spirit lamp: they can be removed one after the other with great rapidity, until only *undrilled* glasses remain, and to these other squares may be added if necessary. To make an oval cell, two round holes (fig. 5, *a*, *b*,) must be drilled so as to intersect each other; their proximity to be determined by the *length* of the oval required. The pieces that remain on each side, *c*, *d*, can be cut off with the diamond if the glass do not exceed one-eighth of an inch thick, otherwise a disc of copper, the diameter of a ten cent piece must be applied to the lathe, charged with sand and water on the edge, and it will speedily make the sides of the cell level.

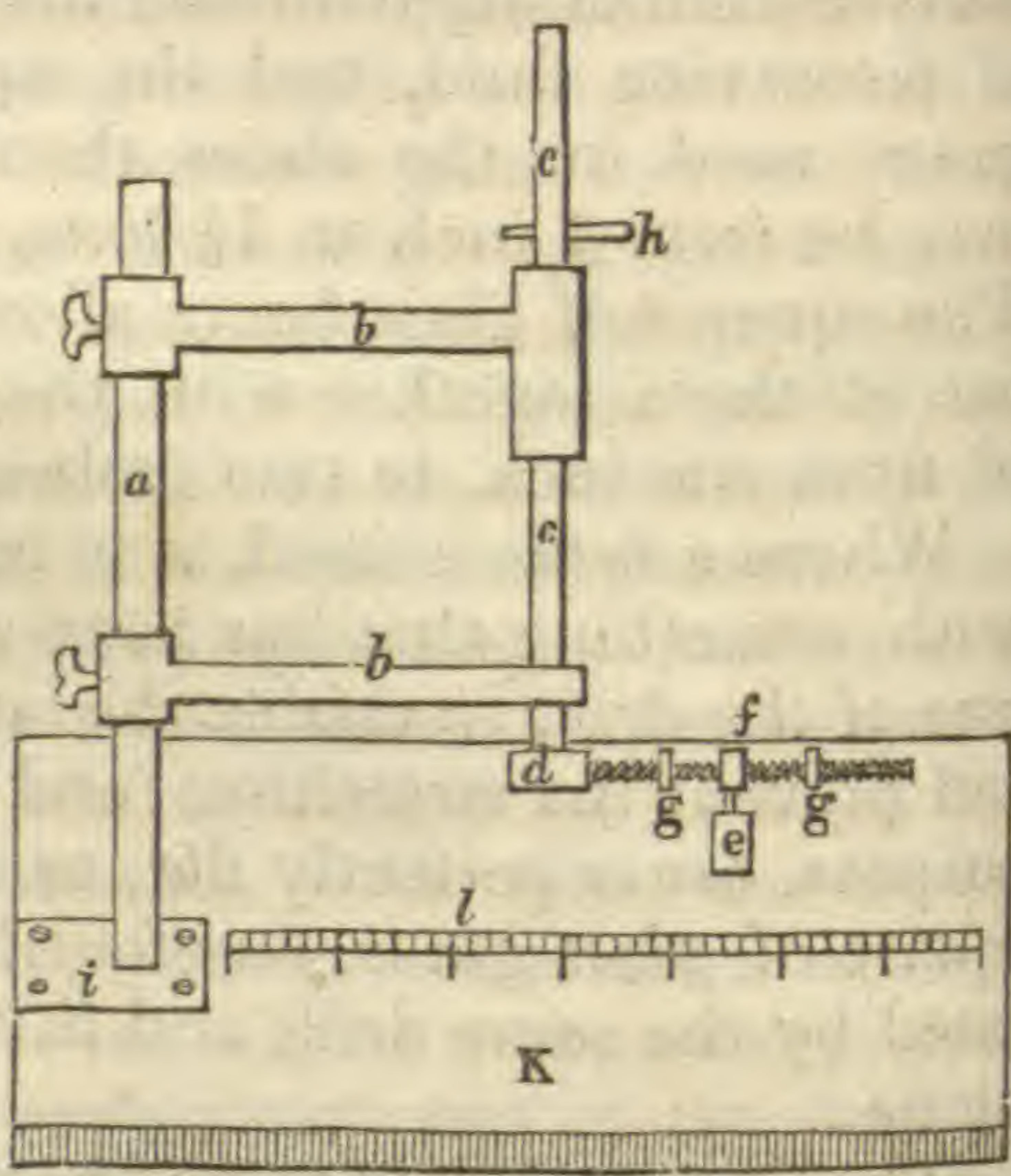
5.



There is another excellent method of cutting either round or oval cells of any size, *provided the glass do not exceed one-eighth inch in thickness*, for which I am indebted to Sir Charles

Babbage, the inventor of the celebrated calculating machine. Mount a glazier's diamond to cut a circle; this can be done in a variety of ways—I have mounted my diamond as shown in fig. 6. *a* represents a square bar of iron, 8 inches long, with a male screw at the lower end to fit a plate of iron (*i*) tapped to receive it, *b*, *b*, two arms 4½ inches long, clamped to the upright bar by thumb screws, the other extremity drilled and ground to receive *c*, which is a spindle, to the lower end of which is rivetted a screwed rod *d*, 4 inches long from the center. *e* is a box to receive the glazier's diamond when removed from the handle, and kept in its place by a tightening screw; continuous with this box is a square nut, *f*, perforated with a hole large enough to allow it to swing freely on the screwed arm. *g*, *g*, are square screwed nuts, one on each side of the diamond box.

6.



In adjusting the diamond to cut a disc, say three inches diameter, move it along the screwed arm until the point be coincident with 1½ inch as marked upon the scale (*l*) which has before been drawn upon the chamois leather which covers the board K; then bring the nuts close to either side of the diamond box, adjust it to its cutting angle, and then by means of a wrench in each hand *tighten* the nuts simultaneously. The glass to be cut may now be placed upon the board; remove the pin *h*, and lower the spindle (*c*) till the diamond touch the glass: then holding the screwed arm by one hand, turn it steadily round and it will describe a circle of the size to which the diamond has been previously adjusted.

As the spindle has been ground to fit the two collars through which it works, the motion is smooth and steady. Such a machine would be improved by casting the upright bar and the two arms in one piece: the height need not exceed six inches. Having cut a circle on a piece of glass, if the *disc* be wanted, cut the glass in three or four places *from the circular cut to the outer edge*, and carefully break off the pieces; but if a *cell* be wanted the *disc must be removed* without injury to the remainder of the glass, which is to form the walls of the required cell.

The cut, already made, gives the exact dimensions of the aperture required; now alter the position of the diamond on the screwed arm and cut a circle *within* the first, adjust again and cut another circle within the last and so proceed cutting circle within circle as long as the diamond can be adjusted to cut, and the glass will then present a series of concentric circles.

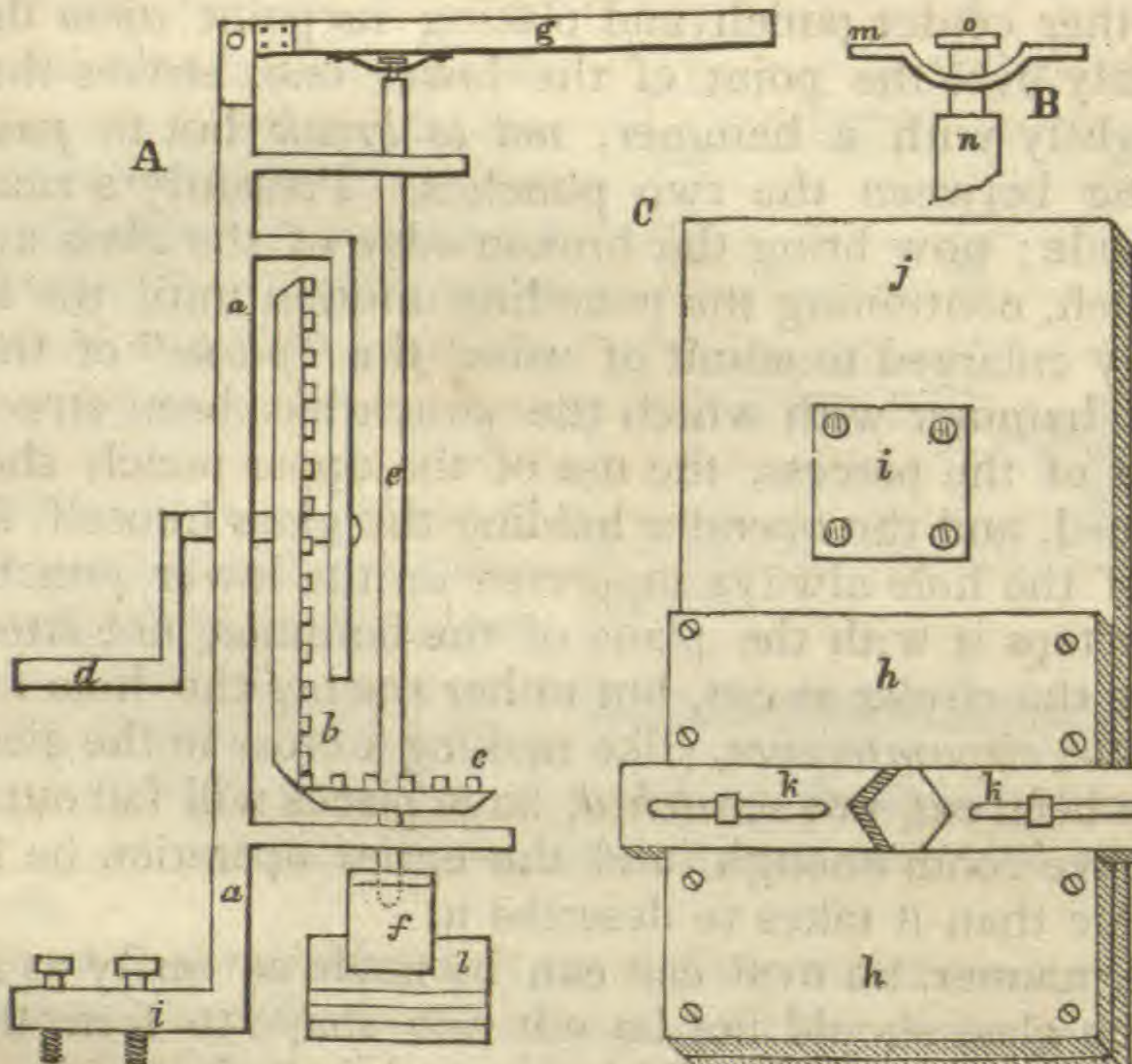
Take a center punch and screw it point upwards in a bench vice; place the center of the *innermost circle* on the point of the punch, and get an assistant to hold the glass while the operator takes another center punch and placing its point *upon* the glass immediately over the point of the lower one, strikes the upper punch lightly with a hammer, *not to break* but to *pound* the glass lying between the two punches. Presently a small hole will be made; now bring the broken edge of the glass upon the lower punch, continuing the pounding motion until the hole be sufficiently enlarged to admit of using the "*plane*" of the small and light hammer with which the punch has been struck. At this stage of the process, the use of the upper punch should be discontinued, and the operator holding the glass himself, keeping an edge of the hole always supported on the lower punch while he lightly taps it with the plane of the hammer, not attempting to remove the *circles* as cut, but rather tracing the hole from the *center to the circumference*, (like making a cross in the glass,) and if it have been *cut*, not *scratched*, large pieces will fall out as soon as they have room enough, and the entire operation be finished in less time than it takes to describe it.

In like manner, an oval cell can be made as easily as a round one. The glass should not be cut into shape to form the *outer* dimensions of the cell until the central hole be made, as it is likely to break. Upon this plan a hole of any size can be easily cut in a plate of glass of any dimensions. Sir Charles Babbage told me that he once communicated this plan to a glazier, who employed it most extensively in punching holes in squares of glass to form the bottom plates of street gas lamps, for the transmission of the gas pipe.

I have already remarked that the above plan of cell-making is limited to glass one-eighth of an inch thick; my wants frequently required cells full as deep again; I could cement two or more shallow ones together and thus build up any required depth, but they look heavy and I prefer therefore to cut them out of plate glass of the proper thickness. When in London I could obtain the services of Mr. Dennis to cut anything that I required, at any time; but in this country, at this moment, I am altogether thrown upon my own resources. To meet my wants I have contrived a small, portable, and most efficient apparatus, by means of which any lad can cut cells as well as I can, and with this machine my son has cut for me the best cells I have ever had.

It consists of *a*, *a*, (fig. 7, A,) an iron support with three arms and a square plate at the lower end of it, cast in one piece. *b*, a vertical beveled wheel working *c*, a horizontal beveled wheel by means of the crank *d*, the latter wheel, having for its axis a spindle, *e*, the lower end of which screws into the brass mount of the copper drill, *f*, whilst its other end passes through a collar in the upper arm of the iron support and is regulated in its action by the wooden lever *g*.

7.



Attached to the under surface of the wooden lever is a strong steel spring, about one inch wide, the profile of which is shown at B, fig. 7. *m* is the spring, to be screwed to the lever by the flat extremities. In the center of the curved portion there is a slit through which the upper part of the spindle, *n*, previously reduced for that purpose passes, and in which it can freely play; it is kept in its place by the button *o*.

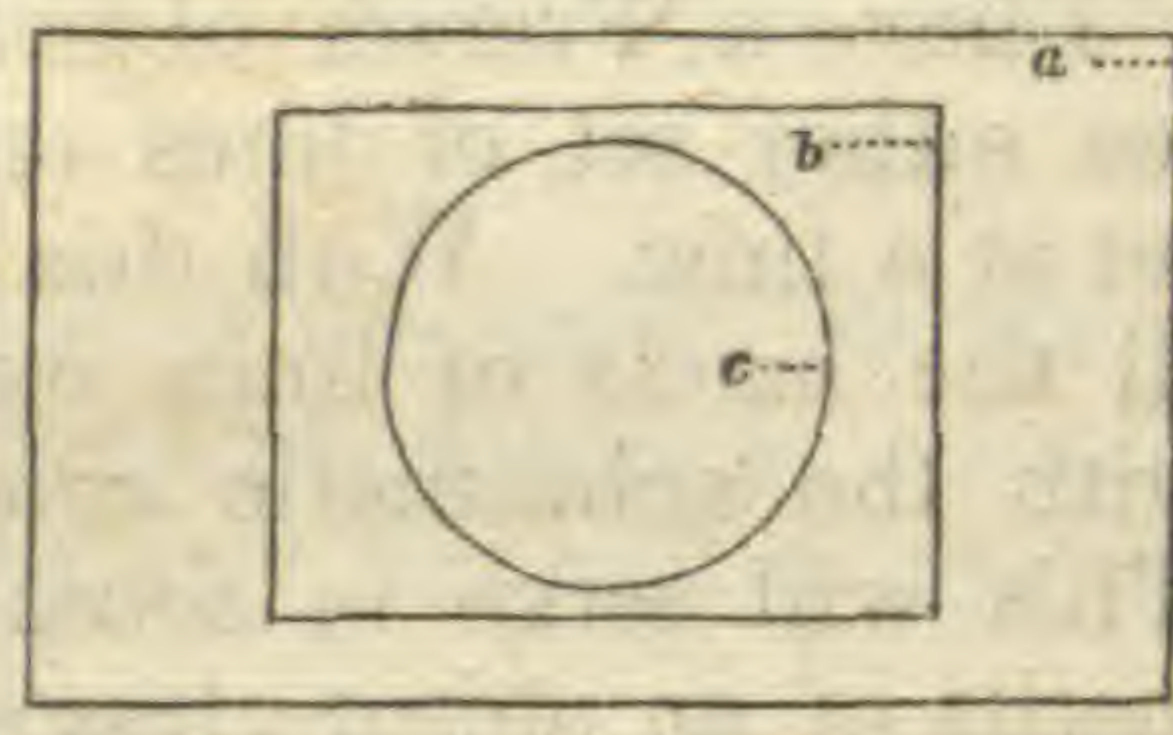
The square plate *i*, (A and C,) is screwed down to the board *j*, by four nut-headed screws. *h*, *h*, are two thick pieces of wood screwed on to the bottom board *j*, their inner edges being under cut to form a beveled groove in which the two pieces of wood marked *k*, being beveled to the same angle, may freely move.

In the center of the pieces marked *k* is a slit, through which passes a nut-headed screw to connect them with the lower board and to admit of their adjustment, their inner extremities are cut to form half a square and are intended to receive the block of glass placed diagonally, to be drilled by the machine. The block of glass, *l*, should be placed exactly in the center, and it can easily be secured in its position by clamping the side pieces of wood by means of the nut-headed screws and collars.

With this machine I employ superfine emery and water. It cuts best by a *dragging* motion; pulling the crank half round with one hand whilst the lever is kept down by the other; and then lifting up the lever and allowing *the crank to go the other half round without grinding.* By alternately lifting up the lever and pressing it down, the emery works into the cut; whereas, if the lever be kept steadily down either by a weight or by the hand, and the crank turned constantly round, the drill will be cut away much faster than the glass. This is not an expensive apparatus.*

The same directions apply to cementing the round and oval cells to the slides as those already given; and when finished they appear like fig. 8, where *a* represents the slide, *b* the cell cemented to it, and *c* the *well* formed for the reception of the preparation and the fluid.

8.



ART. IV.—*Notice of a new Object Glass made by Charles A. Spencer of Canastota, N. Y.;* by ALEXANDER S. JOHNSON, Esq.

Dear Sir:—In the latter part of July last I had the pleasure of visiting Mr. Spencer at Canastota, and of seeing a $\frac{1}{12}$th inch objective which he had then lately completed upon his new formula. Its qualities and performances so far exceeded those of any objective that I have ever seen or heard of, that I cannot doubt your microscopic readers will be pleased to be informed of them. Its angle of aperture was measured by us, with a brass circle graduated to half degrees. The body of the microscope was adjusted upon the circle so as to bring the objective to its focal distance from the centre of motion and the objective was illuminated by the direct rays of the sun, care of course being taken that no reflected rays should fall upon it. We measured from the point on one side where the extreme edge of the field was dark, the rest being full of light, to the corresponding point on the other side. The angle thus given upon repeated trials was $174\frac{1}{2}°$.

The objective was then adjusted upon a Navicula Spencerii, one of the smallest individuals of that species, illuminated by

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* Holes can only be drilled in the *very thin* glass, (that used for covers,) only by cementing a number of them together and *facing* them with a thicker glass; I could not procure any, some years ago, until I suggested this plan, which obviated all difficulty.

[A very convenient method of obtaining circular cells is to take a thick glass tube of requisite bore and have slices sawed off, of the thickness desired. This method has been recommended to us by Dr. J. Leidy of Philadelphia.—EDS.]

reflection of a white cloud from the concave mirror placed not obliquely but with its centre in the axis of the microscope. In this way the shell was well resolved into dots.

At my suggestion a $\frac{1}{4}$th objective of French manufacture was then used for illumination as an achromatic condenser, with the light from a white cloud reflected by the plane mirror, the whole accurately adjusted to the axis of the microscope and the image of the cloud brought in focus in the plane of the object. The dots upon the shell were thus shown with a sharpness of definition that I have never seen equalled by any other objective with any mode of illumination.

I have a French objective with which by oblique light I can see either set of lines on the Navicula Spencerii, but only one set at a time. With this objective and oblique light I can resolve all the bands of lines on Nobert's test of fifteen bands, while with the achromatic condenser I can only resolve nine bands. This will serve in some measure to illustrate the comparative merits of an object-glass capable of showing the dots on the N. Spencerii by oblique light and of one capable of showing them by an achromatic condenser.

We afterwards looked at a Grammatophora subtilissima from Greenport, with the achromatic condenser and the same adjustment, and I saw the cross lines steadily and with perfect distinctness, getting at the same time by glimpses the longitudinal lines.

The light failing us, as evening was approaching, we did not try in this way either the Amici test or the Providence Grammatophora, but in the evening we saw both these objects satisfactorily resolved into dots, by unreflected oblique light from one wick of a common bed-chamber lamp, burning oil, a homely but very effective method of illumination for objectives of large aperture.

Had I not lately met with "a complete manual on the use of the microscope, by Dr. Wythes of Philadelphia," in which in the enumeration of the makers of object-glasses, no mention is made of Spencer, while all persons desirous to see the markings on test objects are directed to mount them dry, I should not think it necessary to add that all the objects above mentioned were mounted in balsam.

The working distance of this objective, notwithstanding its immense angle of aperture is so great that it may be used upon objects covered with thin glass of medium thickness. Comparing the performances of this objective with the recorded performances of other object glasses which from time to time have appeared in the Journal, I cannot resist the conviction that it is the best objective ever produced, and far the best.

New York, Oct. 9, 1851.

ART. V.—*Notice of some undescribed Infusorial Shells;* by ALEXANDER S. JOHNSON, Esq.

IN a recent examination of the Piscataway and Richmond earths, guano from the Chincha islands off the coast of Peru and the so-called "Bermuda" earth, I have found a few infusorial shells heretofore unknown to me, and undescribed by Ehrenberg in his published lists of those localities. I have therefore ventured to describe them. Three of the species belong to a new genus, here described, the fourth is an Asterolampra, and the fifth appears to be a Eupodiscus.

ASTERODISCUS, n. g.—Free animalcules of the family Bacillaria, section Naviculacea. Lorica simple, bivalve, siliceous, circular, from the side biconvex, not forming chains. Umbilicus smooth, nearly circular, divided from its margin to the centre by imperfect septa, of which two unite midway to the centre, the rest radiating; between these septa the umbilicus is produced to the margin of the shell in radii, which are smooth and flat, the one proceeding from between the two united septa being in all species and individuals smaller than the others, as if from imperfect development. The space between these radii elegantly marked with minute dots arranged in eccentric curves.

The proximate genera Asterolampra and Asteromphalus are readily distinguished from this genus. In the former, all the divisions are symmetrical; in the latter, two umbilical septa are nearly parallel and the corresponding marginal radius is wanting.

The following are the three species observed:—

A. quinarius, with five marginal radii and umbilical divisions. Fossil in the so-called Bermuda earth.

A. senarius, with six radii and divisions. Fossil with the foregoing.

A. nonarius, with nine radii and divisions. Fossil at Piscataway, Md., and with the foregoing.

The other new species detected are as follows:—

Asterolampra septenaria, differs from A. marylandica, only in having seven radii instead of eight. Fossil in earth from Richmond, Va., and Piscataway, Md.

Eupodiscus? Tripes. Disc cellular like Coscinodiscus radiatus, with three tubular processes like those of the Eupodisci. Fossil in Chincha guano, near the coast of Peru.

ART. VI.—*On Coral Reefs and Islands;* by JAMES D. DANA. Part Fifth.

From the Report on Geology of the Exploring Expedition under Capt. Wilkes, U.S.N.

2. *Causes modifying the Forms and Growth of Reefs.*

CORAL reefs although (1) *dependent on the configuration of the submarine lands for many of their features*, undergo various modifications of form or condition through the influence of extraneous causes, such as (2) *unequal exposure to the waves;* (3) *oceanic or local currents;* (4) *presence of fresh or impure waters.* In briefly treating of these topics, we may consider first, reefs around high islands, and afterwards, atoll reefs. The effect of the waves on different sides of reefs has already been considered, and we pass on, therefore, at once to the influence of oceanic or local currents, and fresh or impure waters.

a. Barrier and Fringing Reefs.—The *existence of harbors* about coral-bound lands, and of entrances through reefs, is largely attributable to the action of tidal or local marine currents. The presence of freshwater streams has some effect towards the same end, but much less than has been supposed.*

There are usually strong tidal currents through the reef channels and openings. These currents are modified in character by the outline of the coast, and are strongest wherever there are coves or bays to receive the advancing tides. The harbor of Apia, on the north side of Upolu, affords a striking illustration of this general principle. The coast at this place has an indentation 2000 yards wide and nearly 1000 deep, as in the accompanying sketch, reduced from the chart by the Expedition. The reef extends from either side or cape a mile out to sea, leaving between, an entrance for ships. The harbor averages ten feet in depth, and at the entrance is fifteen feet. In this harbor there is a remarkable out-current along the bottom, which during gales, is so strong at certain states of the tide, that a ship at anchor, although a wind may be blowing directly in the harbor, will often ride with a slack cable; and in more moderate weather the vessel may tail out *against* the wind. Thus when no current but one inward is perceived at the surface, there is an under current acting against the keel and bottom of the vessel, which is of sufficient strength to counteract the influence of the winds on the rigging and hull. The cause of such a cur-

HARBOR OF APIA, UPOLU.

* The view here supported, is nearly identical with that presented by Mr. Darwin, (op. cit., page 68.) The arguments given were, however, written out in 1840, before his descriptions of coral islands were known to me. This fact may give additional weight to the opinions, inasmuch as they are therefore the conclusions of independent observers, and are substantiated by a distinct set of observations.

rent is obvious. The sea is constantly pouring water over the reefs into the harbor, and the tides are periodically adding to the accumulation; the indented shores form a narrowing space where these waters tend to pile up: escape consequently takes place along the bottom by the harbor-entrance, this being the only means of exit. This is a correct history of numerous cases about all the islands. In a group like the Feejees, where many of the islands are large, and the reefs very extensive, the currents are still more remarkable, and they change in direction with the tides. The general mode of action, however, is the same.

A current of water of the kind here represented, will carry out much coral debris, and strew it along its course. The transported material will vary in amount from time to time, according to the force and direction of the current. It is therefore evident that the ground over which it runs is wholly unfit for the growth of coral, since zoophytes are readily destroyed by depositions of earth or sand, and require a firm basement to commence growth. The existence of an opening through a reef requires, therefore, no other explanation; and it is obvious that harbors may generally be expected to exist wherever the character of the coast is such as to produce currents and give a fixed direction to them.

The currents about the reef grounds west of the large Feejee Islands, aid in distributing the debris both of the land and the reefs. In some parts, the currents eddy and deposit their detritus; in others they sweep the bottom clean. Thus, under these varying conditions, there may be growing corals over the bottom in some places and not in others; and the reefs may be distributed in patches, when, without such an influence, we should expect a general continuity of coral reef over the whole reef-grounds.

The results from marine currents are often increased by waters from the island streams; for the coves, where harbors are most likely to be found, are also the embouchures of valleys and the streamlets they contain. The fresh waters poured in, add to the amount of water and increase the rapidity of the out-current. At Apia, Upolu, there is a stream thirty yards wide; and many other similar instances might be mentioned. These waters from the land bring down also much detritus, especially during freshets, and the depositions aid those from marine currents in keeping the bottom clear of growing coral. These are the principal means by which freshwater streams contribute towards determining the existence of harbors; for little is due to their freshening the salt waters of the sea.

The small influence of the last-mentioned cause—the one most commonly appealed to—will be obvious, when we consider the size of the streams of the Pacific islands, and the fact that fresh water is lighter than salt, and therefore, instead of sinking, flows on over its surface. The deepest rivers are seldom over six feet, even at their mouths; and three or four feet is a more usual depth. They will have little effect, therefore, on the sea water beneath this depth, for they cannot sink below it; and corals may consequently grow even in front of a river's mouth. Moreover, the river water becomes mingled with the salt, and, in most cases, a short distance out, would not be unfit for some species of coral zoophytes.

Yet when the rivers are large, like those of continents, the influence of the freshening waters is very decided, and prevails often over a wide extent of coast.

Freshwater streams, acting in all the different modes pointed out, are of little importance in harbor-making about the islands of the Pacific. The harbors, with scarcely an exception, would have existed without them. They tend, however, by the detritus they deposit, to keep the bottom more free from growing patches of coral, and consequently produce better anchorage ground: moreover, within the harbors they usually keep channels open through or over the shore reef sufficiently deep and wide for a boat to reach the land, and sometimes preserve a clean sand-beach throughout. That this is their principal effect will appear from a few facts.

The figure on page 366, vol. xi, of this Journal, has been described as a map of the reef of North Tahiti, between Papieti on the left, and Venus Point on the right.

a. The harbor of Papieti is enclosed by a reef about three-fourths of a mile from the shore. The entrance through the reef is narrow, with a depth of eleven fathoms at center, six to seven fathoms either side, and three to five close to the reef. This fine harbor receives an unimportant streamlet, while a much larger stream empties just to the east of the east cape, *opposite which the reef is close at hand and unbroken.*

b. Toanoa is the harbor next east of Papieti. The entrance is thirty-five fathoms deep at middle, and three and a half to five fathoms near the points of reef. There is no freshwater stream, excepting a trifling rivulet.

c. Papaoa is an open expanse of water, harbor-like in character, but is without any entrance; the reef is unbroken. Yet there are two streams emptying into it, one of which is of considerable size.

d. Off Matavai, the place next east, the reef is interrupted for about two miles. The harbor is formed by an extension of the reef off Point Venus, the east cape. There is no stream on the coast, opposite this interruption in the reef, except towards Point Venus, and at the present time the waters find their principal exit, east of the Point, behind a large coral reef, but a quarter of a mile distant.

From such facts, it would almost seem as if coral reefs grew best near freshwater streams. We cannot be surprised at the little influence they appear to have exerted when knowing that none of these so-called rivers are over three feet in depth; and the most that they can do is to produce a thin layer of brackish water over the sea within the channels.

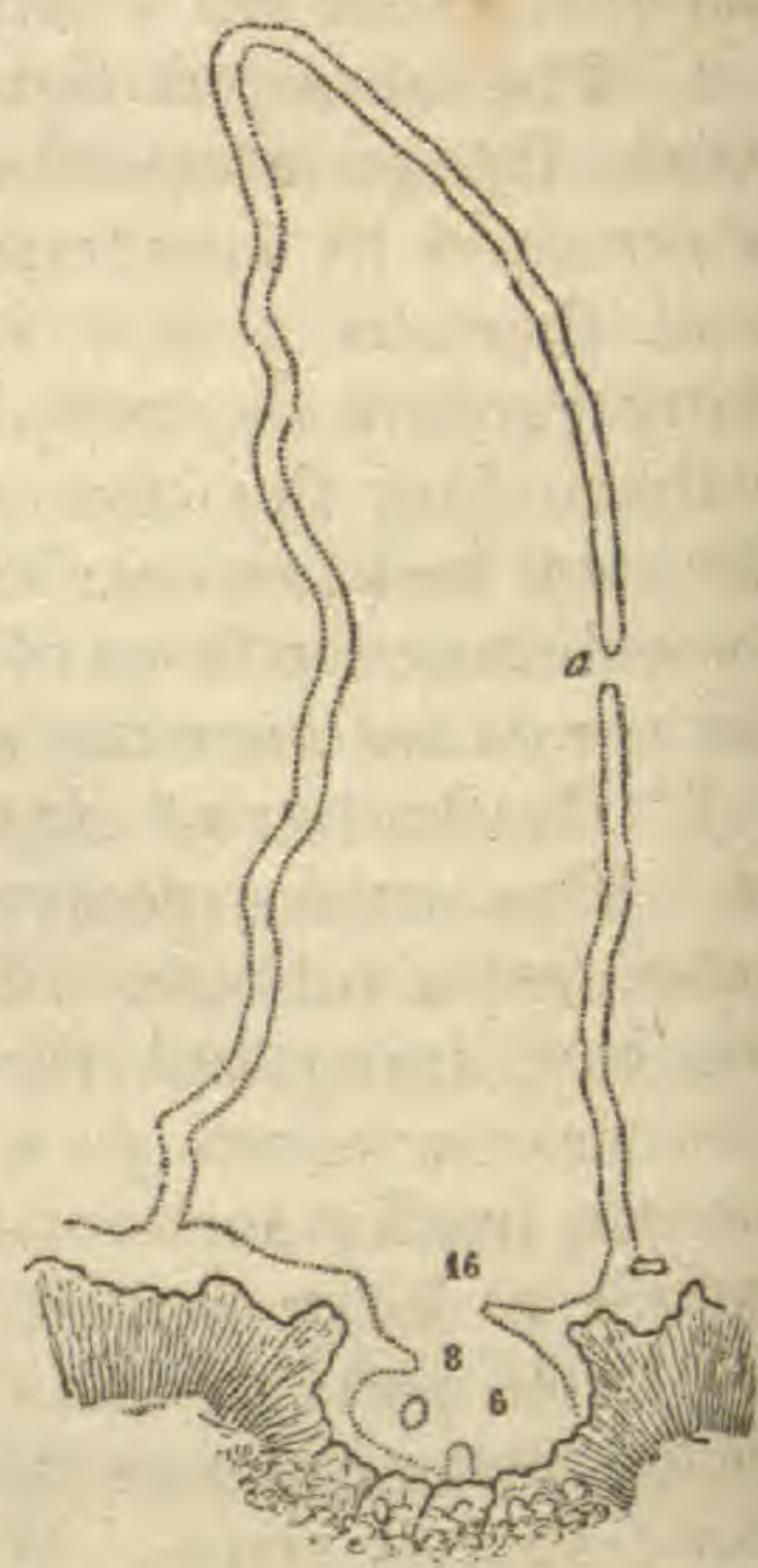
e. The annexed figure of the harbor of Falifa, Upolu, represents another coral harbor, as surveyed by Lieutenant Emmons. At its head there is a fine stream twenty-five or thirty yards wide, and three feet deep. Notwithstanding the unusual size of the river, the coral reef lies near its mouth, and projects some distance in front of it. Its surface is dead, but corals are growing upon its outer slope.


HARBOR OF FALIFA.

f. The harbor of Rewa, in the Feejees, may be again alluded to. The waters received by the bay amount to at least 500,000 cubic feet a minute. Yet there is an extensive reef enclosing the bay, lying but three miles from the shores, and with only two narrow openings for ships. The case is so remarkable that we can hardly account for the facts without supposing the river's mouth to have neared the reef by depositions of detritus since the inner parts of the reef were formed; and there is some evidence that this was the case, though to what distance, we cannot definitely state. With this admission, the facts may still surprise us; yet they are explained on the principle that fresh water does not sink in the ocean, but is superficial, and runs on in a distinct channel; its effect is almost wholly through hydrostatic pressure, and detritus depositions. Besides these instances, there are many others in the Feejees, as will be observed on the Expedition charts. Mokungai has a large harbor, without a stream of fresh water;—so also Vakea, and Direction Island.

The instances brought forward are a fair example of what is to be found throughout coral seas; and they establish, beyond dispute, that while much in harbor-making should be attributed to the transported sand or earth of marine and freshwater currents, in preventing the growth of coral, but little is due to the freshening influence of the streams of the islands.

But while observing that currents have so decided an influence on the condition of harbors, we should remember another prevalent cause, already remarked upon, and perhaps more wide in its effects than those just considered. I refer to the features of the supporting land, or the character of soundings off a coast. We need not repeat here what has already been dwelt upon, showing that many of the interruptions of reefs have thus arisen. The wide break off Matavai may be of this kind. The widening of the inner channel at Papieti, forming a space for a harbor, may be another example of it; for the reef here extends to a greater distance from the shores, as if because the waters shallowed more gradually outward off this part of the coast. The same cause—the depth of soundings, on the principle that corals do not grow where the depth much exceeds a hundred feet—has more or less influence about all reefs in determining their configuration and the outlines of harbors. A remarkable instance of the latter is exemplified in the annexed chart of Whippey harbor, Viti Lebu, reduced from the chart of the Expedition to the scale of half an inch to the mile.



WHIPPEY HARBOR, VITI LEBU.

The existence of harbors should therefore be attributed, to a great extent, to the configuration of the submarine land; while currents give aid in preventing the closing of channels, and keeping open grounds for anchorage. This subject will be further illustrated in the following pages.

The permanency of coral harbors follows directly from the facts above presented. They are secure against any immediate obstruction from reefs. Any growing patches within them may still grow, and the margins of the enclosing reefs may gradually extend and contract their limits; yet only at an extremely slow rate. Notwithstanding such changes, the channels will remain open, and large anchorage grounds clear, as long as the currents continue in action. Coral harbors are therefore nearly as secure from any new obstructions as those of our continents. The growing of a reef in an adjoining part of the coast may in some instances diminish or alter the currents, and thus prepare the way for more important changes in the harbors; but such effects need seldom be feared, and results from them would be appreciable only after long periods, since the growth of reefs is very slow in the most favorable circumstances.

When channels have a bottom of growing coral, they form an exception to the above remark; for as the coral is acted upon by no cause sufficient to prevent its growth, the reef will continue to rise slowly towards the surface.

Again, when the channels are more than twenty fathoms in depth, they have an additional security beyond that from currents, in the fact that corals will not grow at such a depth. The only possible way in which such channels could close, without first filling up by means of shore material, would be by the extension of the reef from either side, till they bridge over the bottom below. But such an event is not likely to happen in any but very narrow channels.

In recapitulation, the existence of passages through reefs, and the character of coral harbors may be attributed to the following causes:

1. The configuration and character of the submarine land;—corals not growing where the depth exceeds certain limits, or where there is no firm basement for the plantation.

2. The direction and force of marine currents with their transported detritus;—these currents deriving their course, as in other regions, from the features of the land, the form of the sea-bottom and the reefs, and being sometimes increased in force by the contributions of island streams, which add to the detritus and to the weight of accumulating waters.

3. Harbors which receive freshwater streams or submarine springs of freshwater, are more apt to be clear from sunken patches; and the same causes keep open shallow passages to the shores, where there are shore reefs.

It should be remembered, that while the effects from freshwater streams are so trifling around islands, they may be of very wide influence on the shores of continents, where the streams are large and deep, and transport much detritus. This point is illustrated beyond.

b. Atoll Reefs.—The remarks in the preceding pages respecting reefs around other lands, apply equally to atoll reefs. There are usually currents flowing to leeward through the lagoon, and out, over or through the leeward reef, and this action, as with the coral harbor, tends to keep open a leeward channel for the passage of the water. This is the common explanation of the origin of the channels opening into lagoons. These currents are strongest when the windward reef is low, so as to permit the waves in some parts to break over it; and the coral debris they bear along will then be greatest. When a large part of the leeward reef is under water, or barely at the water's edge, the waters may escape over the whole, and on this account we sometimes find large reefs without any proper channels. As the land to windward becomes raised throughout above the sea, and forms a continuous line which the waves cannot pass, the current is less perfectly sustained, being dependent entirely upon the influx and efflux of the tides; and the leeward channels, in such a case, may gradually become closed.

The action of currents on atolls is, therefore, in every way identical with what has been explained. The absence of coves of land to give force to the waters of currents, and to direct their course, and the absence also of freshwater streams, are the only modifying causes not present. It is readily understood, therefore, why lagoon entrances are more likely to became filled up by growing coral, than the passages through barrier reefs.

3. *Rate of Growth of Reefs.*

The formation of a reef has been shown to be a very different process from the growth of a zoophyte. Its rate of progress is a question to be settled by a consideration of many distinct causes, and the rapid voyage of an Expedition affords no opportunity for definite conclusions.

a. The rapidity of the growth of zoophytes is an element in this question of great importance, and one that should be determined by direct observation with respect to each of the species which contribute largely to reefs, both in the warmer and colder parts of coral-reef seas.

b. The character of the coral plantation under consideration should be carefully studied: for it is of no little consequence to know whether the clusters of zoophytes are scattered tufts over a barren plain, or whether in crowded profusion. Compare the debris of vegetation on the semideserts of California with that of regions buried in foliage; equally various may be the rate of growth of coral rock in different places. Some allowance should also be made for the shells and other reef relics. The amount of reef rock formed in a given time cannot exceed, in cubic feet, the aggregate of corals and shells added by growth—that is, if there are no additions from other distant or neighboring plantations.

c. It is also necessary to examine into whatever has any bearing upon the marine or tidal currents of the region—their strength, velocity, direction, where they eddy, and where not, whether they flow over reefs that may afford debris or not. All the debris of one plantation may sometimes be swept away by currents to contribute to other patches, so that one will enlarge at the expense of others. Or, currents may carry the detritus into the channels or deeper waters around a coral patch, and leave little to aid the plantation itself in its increase and consolidation.

d. The course and extent of fresh waters from the land, and their detritus, should be ascertained.

e. The strength and height of the tides, and general force of the ocean waves, will have some influence.

Owing to the action of these causes, barrier reefs enlarge and extend more rapidly than inner reefs. The former have the full action of the sea, and are farther removed from the deleterious influences which may affect the latter.

As stated above, no results were arrived at from observations made in the course of the voyage through the Pacific. The general impression that their progress is slow, was fully sustained. The facts, with regard to the growth of zoophytes, give some data, though by no means satisfactory.

If we allow that Madrepores may grow three inches a year, it is far from admitting that a reef may increase as rapidly. In the best coral plantations, not over one-third of the surface is covered with growing zoophytes. It would therefore follow, supposing all the species to grow at this rate, and all the material to be retained on the plantation, that in twelve months the reef might possibly increase one inch in height; including shells and other animal remains, it might, perhaps, be one and one-quarter inches. This estimate is based on too many assumptions to be received with any confidence, except it be the confidence that the result is overrated.

With reference to this subject, by the order of Captain Wilkes a slab of rock was planted on Point Venus, Tahiti, and by soundings, the depth of Dolphin shoal, below the level of this slab, was carefully ascertained. By adopting this precaution, any error from change of level in the island, was guarded against: the slab remains as a stationary mark for future voyagers to test the rate of increase of the shoal. Before, however, the results can be of any general value towards determining the average rate of growing reefs, it is still necessary that the growing condition of the reef should be ascertained, the species of corals upon it be identified, and the influence of the currents investigated which sweep in that direction out of Matavai bay.

The depth to which Chamas or Tridacnas lie imbedded in coral rock, has been supposed to afford some data for estimating the growth of reefs. But Mr. Darwin rightly argues that these molluscs have the power of sinking themselves in the rock, as they grow, by removing the lime about them. They occur in the dead rock,—generally where there are no growing corals, except rarely some small tufts. If they indicate anything, it must be the growth of the reef rock, and not of the corals themselves. But the shore-platform where they are found is not increasing in height. They resemble, in fact, other saxicavous molluscs, several species of which are found in the same seas, some buried in the solid masses of dead coral lying on the reef. The bed they excavate for themselves is usually so complete that only an inch or two in breadth of their ponderous shells are exposed to view. Without some means like this of securing their habitations, these molluscs would be destroyed by the waves; a tuft of byssus, however strong, which answers for some small bivalves, would be an imperfect security against the force of the sea for shells weighing one to five hundred pounds.

ART. VII.—*Notices of Botanical Literature, &c.*, in a letter to one of the Editors; by A. GRAY.

My Dear Sir:—I shall be glad to make up for past remissness, and redeem my promises as far as I now may, by sending you some off-hand notes upon botanical matters, whether bibliographical or personal; if you will kindly receive them just as they are recalled to my memory, or as the books I wish to mention are presented to my notice. If I can thus give to the readers of your excellent Journal, interested in such topics, some general idea of what has been doing in the botanical world for a year or two past, or is now in progress, my whole object will be attained. Writing without memoranda, or any definite order, I shall doubtless omit much that should be mentioned, even of what may have fallen under my personal observation.

Having Systematic Botany principally in view, at present, I naturally begin with the most important general systematic work now in progress, viz., *De Candolle's Prodromus.* Nothing has been published since the second part of the 13th volume, in the spring of 1849, (which was duly noticed in your Journal at the time,) not even the prior part of this 13th volume, reserved for the remaining *Corolliflorœ.* Botanists will be glad to learn, however, that the *Solanaceœ*, which Prof. Dunal has kept them so long waiting for, are actually printing off, or are by this time entirely printed. The genus *Solanum* is said to exceed even Senecio in the number of its species, which one would hardly have thought, especialy since so many appear to be cosmopolite. The *Plantaginaceœ*, by Prof. Decaisne, will complete that volume, and the series of *Corolliflorœ.* Meanwhile the 14th volume must be in a state of forwardness, though probably none of it is yet printed; for Prof. Meisner of Basle has already worked up the *Polygonaceœ* (excepting the *Eriogoneœ*, which are done by Mr. Bentham), and I believe also the *Thymelaceœ*, *Proteaceœ*, and their immediate allies. I know not who is to attempt the *Laurineœ.*

Botanists cannot but be grateful to Prof. Alphonse De Candolle, for his strenuous and so successful endeavors to carry on the formidable work bequeathed to him, involving as it does a vast amount of labor and care, and offering no pecuniary advantage, since the recent revolutionary times in Europe; and all will regret, but not be surprised to learn, that it is determined to close the Prodromus at the end of the *Exogenœ* or *Dicotyledones*, of which only a small number of orders, some of them very difficult ones, now remain.

Prof. Alph. De Candolle himself is much occupied with an extended treatise of the geographical distribution of plants he has long had in preparation; and has recently published two brief but important articles bearing upon this subject. One of them, "Sur les causes qui limitent les espèces végétales du côté du nord, en Europe et dans les régions analogues," communicated to the French Academy of Sciences, (published in *Ann. Sci. Nat.*, for Jan., 1848.) deduces the law, that each species having its polar limit in central or northern Europe, extends as far northward as it receives a certain fixed amount of heat, calculated (not from the mean temperature of the year but) between the day when there commences and the day that ends a certain mean temperature. The other, "Du mode d'action de la chaleur sur les Plantes, et en particulier de l'effet des rayons solaires" (*Bib. Univ. Genève*, March, 1850), investigated by making growing plants themselves serve as the measure of solar action, goes to show that Boussingault's method of estimating the sum of heat necessary to produce a certain result in a given species, requires still further modification; and that, as might be inferred, the effect of the sun on the thermometer, is far from being a true measure of its action on vegetation.

Shortly after the lamentable death of Prof. Kunth* (which occurred on the 22d March, 1850, at the age of 62), appeared the fifth volume of his *Enumeratio Plantarum*, comprising the Orders *Asparagineæ*, *Smilaceæ*, *Dioscoreaceæ*, and *Amaryllidaceæ*, with some small groups nearly allied to these. Its merits appear to be about the same as of the preceding volumes.

The *Annales Botanices Systematicæ* of Walpers, has not gone beyond the first volume.

Since Endlicher's death, a fifth supplement to the *Genera Plantarum*, or rather a continuation of the fourth supplement, part 2, has been published, from MSS. left by Endlicher and completed by Dr. Fenzl. It is announced on the cover that no MSS. for the first part of this fourth supplement were found. Endlicher's professorship in the Vienna University is divided between Dr. Fenzl, who has also the charge of the Imperial herbarium, and Dr. Unger, of Gratz, the historian of fossil plants, who takes the anatomical and physiological department.

Under the title of *Die Urwelt in ihren Verschiedenen Bildungsperiod* (*Le Monde Primitif à ses différentes époques de Formation*), Prof. Unger has just published a series of fourteen landscape plates, in imperial folio, of high artistic merit as well as scientific interest, representing a scene from each principal geological period, designed especially to reproduce the vegetation; accompanied by forty pages of explanatory text, German and

* A biographical memoir of this distinguished botanist, from the hand of M. Adrien de Jussieu, will be found in the *Annales des Sciences Naturelles*, No. 2, for 1850.

French, in parallel columns. The plates were executed at Munich, in lithography, of the very highest excellence. In this connection, I may call your attention to a highly interesting memoir by Prof. Adolphe Brongniart, in *Ann. Sci. Nat.*, for May, 1849, but not published before nearly the close of that year, entitled, *Exposition Chronologique des Périodes de Végétation, et des Flores diverses qui se sont succèdé a la surface de la Terre.* If some one would take the trouble to make a translation, it would be interesting and useful to reproduce it in your Journal. From the vast predominance in the most ancient formations of Acrogenous Cryptogams (*Ferns* and *Lycopodiaceæ*), succeeded at length by Gymnospermous Dicotyledons (*Cycadeæ* and *Coniferæ*), and from the first appearance in later times, and soon the predominance of Angiospermous Dicotyledons and Monocotyledons, M. Brongniart is led to arrange the floras of the ancient world, considered as to their succession in time, under three great dynasties, viz.,

(1.) *The Reign of Acrogens.*
   1. Carboniferous Period.
   2. Permian Period.

(2.) *The Reign of Gymnosperms.*
   3. Vosgien Period.
   4. Jurassic Period.

(3.) *The Reign of Angiosperms.*
   5. Cretaceous Period.
   6. Tertiary Period. (Each period divided into its several epochs.)

Prof. von Martius having brought to a close his great work on the *Palms*, in three elegant folio volumes, in a style and form commensurate with the grandeur of the subject—a work which requires a separate and detailed notice—he is now enabled to turn his attention again to the *Flora Brasiliensis*, which is now likely to go on, although I am not aware that a new part is actually in press.

The *Genera Floræ Germanicæ Iconibus Illustrata*, begun by Th. F. L. Nees von Esenbeck, and after his death transferred to Prof. Spenner of Friburg in Briesgau, and after his death continued by Endlicher and Dr. Putterlich of Vienna, since the death of both of the latter botanists, has been taken up by Prof. Bischoff of Heidelberg, who is as accomplished a draughtsman as a botanist. I have seen some of his illustrations of *Umbelliferæ*, which will more than sustain the character of this work, but I am not sure whether any new fasciculi have yet been issued.

The recent mortality among the German botanists is very remarkable. Besides those already mentioned, are the following. The veteran Prof. Link, died at Berlin on the 14th of January last, at the age of 85, active almost to the last, and surviving almost a year his unfortunate colleague, Prof. Kunth, as well as his colleague in the Flora of Portugal, Count Hoffmansegge. Prof. Hornschuch of Griefswalde, the eminent muscologist, died on the 7th of January last, also, I believe of advanced age. Prof. Bernhardi of Erfurt, died in May, 1850, aged 76. Prof. Koch of Erlangen, author of the *Flora Germanica*, and long esteemed the best authority in German plants, died in November, 1849, aged 78. In the same month and of the same age, died Dr. Sturm, the Cryptogamist, at Nuremberg; and in the month previous, Prof. Schauer, of Breslau. Prof. Kunze of Leipsic was suddenly struck down by apoplexy, on the last day of April, 1851. Prof. Ledebour, died at Munich on the 4th of July last.

The professorship at Berlin, with the curatorship of the Royal Botanic Garden, having been declined by Prof. Mohl, who was unwilling to leave Tubingen, has been accepted by Prof. Braun, who had shortly before been transferred from Friburg to Giessen, but who will now find fuller scope for his activity and great talents at the Prussian capital. Dr. Mettenius of Heidelberg has been appointed to the chair at Friburg. The chair of the late Prof. Kunze has been assigned, at least for the present, to Prof. Pœppig, the South American traveller.

The distinguished Professor Wahlenberg of Upsal, died on the 23d of March, only a little above seventy years of age; and is succeeded by the celebrated Fries, who has until now held some minor professorship in the University of Upsal, not connected with botany. Prof. Fries has recently published a second part of the *Summa Vegetabil. Scandinaviæ*, and also (in the Upsal Transactions) an elaborate monograph of Hieracium, a genus which gives no small trouble to European botanists.

Ledebour's *Flora Rossica* had been continued down to the end of the Dicotyledones previous to the author's decease; and it is understood that the manuscript for the remainder is very nearly complete.

Mr. Webb, having finished his elaborate *Phytographia Canariensis* during the past year, the splendid *Histoire Naturelle des Iles Canaries*, par MM. P. Barker Webb and S. Berthelot, is now, I believe, complete. The principal labor has fallen upon Mr. Webb himself, Mr. Berthelot having long been absent from France, on a distant colonial appointment. The botanical portion of this great work consists of four volumes (imperial 4to) with 287 plates; besides the volume on Geographical Botany, treating of the general aspect of the vegetation of the Canary Islands, its phytostatic distribution, &c.

Dr. Weddell, one of the more distinguished of the younger botanists of Paris, though an Englishman by birth, now one of the aid-naturalists at the *Jardin des Plantes*, has made a most important contribution to materia medica as well as botany, in his splendid folio *Monograph of Cinchona*,* the result, in part, of a two years' exploration of the peruvian-bark forests of Bolivia and Peru. Dr. Weddell went to South America with M. Castelnau (who was well known to the naturalists of the United States a dozen years ago), and explored with him the interior of Brazil; but leaving that party on the borders of Bolivia in 1845, he devoted himself to this special undertaking until his return to Europe early in 1848. Dr. Weddell is now on a second visit to the same regions. The introduction to his treatise comprises an interesting historical sketch of the principal scientific journeys undertaken into the regions that furnish Peruvian bark, by Condamine, Joseph de Jussieu, Mutis, Ruiz and Pavon, Humboldt and Bonpland, &c., followed by his own itinerary, and an account of the mode in which the bark is sought, gathered, and prepared by the *Cascarilleros*. Then follows the detailed monograph of the genus Cinchona, the anatomy of the bark, and the general characters of all the organs; the geographical distribution of the genus; the detailed history and characters of the species known to the author, nineteen in number, and of the respective products of those which furnish the different barks of commerce.† Dr. Weddell separates all the former Cinchonæ which have the fruit

* *Histoire Naturelle des Quinquinas, ou Monographie du genre Cinchona, suivie d'une description du genre Cascarilla et de quelques autres plantes de la même tribu;* par M. H. A. WEDDELL, Docteur en Médecine. Accompagné de 34 planches, dessinées par Riocreux et Steinheil. Paris: Victor Masson. 1849. (60 francs.)

† It appears that the *cinchonine* is contained principally in the cellular, and the *quinine* in the fibrous, tissue of the living bark, although the most fibrous specimens are not the richest in the latter principle, and the value of a given kind of bark may be judged, to a certain extent, by the appearance of the fracture. Dr. Weddell distinguishes three modifications of fracture; the *corky*, the *fibrous* and the *filamentous* (*filandreuse*), of which the latter indicates a greater richness in quinine than the first, but less than the second. The gray barks, Dr. Weddell shows, are not derived from distinct species, but from the young branches of several different species, the older stems of which furnish red or yellow barks. The *Gray Barks* of Loxa, or *Crown Barks*, are yielded by *Cinchona condaminea*, *C. scrobiculata*, and *C. macrocalyx*. The *Silver Barks*, or *Gray Barks* of Lima or Huanuco, come from *C. micrantha* or *C. lanceolata* and *C. glandulifera*. The *Red Barks* of Lima are yielded by *C. nitida;* the red and brown bark of Carthagena are of uncertain origin. The principal *Yellow Barks* come from *C. Calisaya* of Weddell; the *Orange-Yellow* from *C. micrantha;* the *Woody Carthagena Bark* and *Quinquina Pitaya*, from *C. condaminea;* and the *new spurious Yellow Bark* of Pereira, from *C. lancifolia*. The *Rusty Barks* of Humalies are furnished by *C. hirsuta*, *C. micrantha*, *C. ovalifolia*, and perhaps *C. purpurea*. The *White* or *Ash Barks* of Loxa, &c., come from *C. ovata;* those of Cusco and Arica from *C. pubescens* or *C. ovalifolia*. *Cinchona Calisaya*, *condaminea* and *nitida*, appear to yield the richest kinds of bark.

As to geographical distribution, the genus Cinchona occupies a narrow, ribbon-shaped tract, 29 degrees of latitude in length, and curved, according to the general direction of the Andes, into an arc, with its convexity looking westward, the centre and most westerly part of which is at Loxa. Nearly the whole of it is on the Atlantic slope of the Andes, and it corresponds in a remarkable manner with the innumerable sources of the Amazon. The southern limit is in Bolivia, at lat. 19° S.; the northern at Venezuela, in lat. 10, not far west of Porto Cabello. As to elevation, the Peruvian bark forests are comprised within the extremes of 1200 and 3270 metres.

dehiscent from the apex downwards; the principal part of them forming his genus *Cascarilla*, of which a monograph is subjoined. These *false quinquinas* are distinguished by the greater astringency of their bark, which is destitute both of *Quinia* and *Cinchonia.* The illustrations consist of a view in the Cinchona forest of the valley of *San Juan del Oro*, in Peru, of two plates filled with details of anatomical structure, twenty-three plates exhibiting the species of Cinchona, and five, those of allied genera; three colored plates represent the principal kinds of Peruvian bark, in a very beautiful manner; and a map of the intertropical Andes shows the geographical distribution of the Cinchona forests.

During the past year Mr. Weddell has contributed to the *Annales des Sciences Naturelles*, a remarkable paper on the structure of the *Balanophoreæ* as compared with *Rafflesiaceæ*, the theoretical conclusions of which are more ingenious perhaps than sound.

The appointment of M. Decaisne to the chair of Culture at the *Jardin des Plantes* (as the successor of M. Mirbel, who still survives, although extremely and hopelessly infirm), to the duties of which he is devoting himself with characteristic energy and success, has to a great degree, turned his attention, though only temporarily, it is hoped, from systematic botany.

The ill-health of Prof. Adrien de Jussieu has prevented him from engaging of late in any extensive botanical work, like that upon the *Malpighiaceæ;* but with renovated health, new researches may be expected from this most learned and skillful botanist. M. Gaudichaud, notwithstanding his infirm health, is about to bring to a conclusion the Botany of the Voyage of the Bonite, which, by the contract of the publisher with the Minister of Public Instruction, must be finished at the close of the current year. A large number of plates have already been issued, but without any letter-press of the systematic part; and that veteran and most active cryptogamist, Dr. Montagne, has already completed the cryptogamic portion. The small portion of letter-press already published by Prof. Gaudichaud relates almost exclusively to his theoretical views of vegetable structure, in illustration of which he has formed a cabinet of extremely interesting materials.

Dr. Montagne, who is remarkable for promptly carrying through the work he undertakes, has also completed the Cryptogamic Botany of the Voyage of the Astrolabe and Zelée (D'Urville's); while of the Phanerogamic part, nothing has appeared beyond an atlas of plates, wholly destitute of letter-press.

Of the aid-naturalists at the *Jardin des Plantes*, the principal are M. Weddell, now temporarily absent in South America (as already mentioned); M. Spach, who still goes on with the *Illustrationes Plantarum Orientalium*, in connection with Count Jaubert; M. Naudin, who is sedulously working up in monographs all the *Melastomaceæ* of the Herbarium; and M. Tulasne, who has newly elaborated the *Podostemaceæ* (in 20 genera); and whose researches in vegetable embryogeny, and discovery of *Antheridia* in Lichens, require a notice on another occasion.

M. Claude Gay is still carrying on his elaborate *Historia Fisica et Politica de Chile*, and working up himself a considerable part of the botanical as well as the zoological portion. Of the Flora of Chili four volumes (8vo,) are completed, and half of the fifth volume, extending into the Monochlamydeæ. Also of the seventh, the Cryptogamic volume, the indefatigable Dr. Montagne has brought out two parts, comprising the Musci and a portion of the Hepaticæ. The technical characters are given in Latin, the detailed descriptions and the observations are in Spanish. It is illustrated by an atlas of admirable plates (in short folio,) from drawings by Riocreux, the most accomplished of botanical draughtsmen. The work, a truly national one, is sustained, in great part, by Chilian subscribers. One of M. Gay's best collaborators, M. Remy, after elaborating the Compositæ for this work (in a manner on the whole very creditable,) has been sent, by the administration of the museum, to make a botanical investigation of the Sandwich Islands.

In the death of M. Benj. Delessert science has lost a most enlightened and liberal patron; but it is pleasant to know that the unrivalled library and rich herbarium, and whole scientific establishment are kept up as aforetime, in the Rue Montmatre, by his excellent brother, M. François Delessert; and M. Lasègue the curator is still in daily attendance upon the botanists who flock there to consult these precious collections.

Prof. Richard has made some further progress of late with the botanical part of Ramon de la Sagra's *Historie Physique Politique et Naturelle de l'Ile de Cuba*, (that is, with the *Plantes Vasculaires;* the *Plantes Cellulaires* having long since been completed by Dr. Montagne;) and he has just finished his *Flore de l'Abyssinie* (2 vols. 8vo, with a folio atlas).

M. Boissier, of Geneva, had brought out eleven parts of his *Diagnoses Plantarum Orientalium*, the result, principally of his own explorations in the East, when he was interrupted by a grevious domestic affliction. His extensive herbarium has lately been much increased by the purchase of the herbarium of Pavon, rich in American plants, in complete and well-preserved specimens. It was purchased in Spain, through the instrumentality of his colleague and curator, M. Reuter.

Prof. Choisy of Geneva is occupied with a revision of the *Guttiferæ:* M. Duby, with the lower Cryptogamus plants, and with a new edition of the *Synopsis Floræ Galliæ et Helvetiæ*. Prof. Godet of Neuchatel is engaged upon a Flora of the Jura; and Mr. Shuttleworth, of Berne, with the fine collections of Florida and Key West plants sent him by Rugel.

Prof. Lehmann of Hamburgh is engaged upon a new and fuller monograph of *Potentilla*, a genus upon which he has written so much, and of which he has accumulated the amplest materials. Meanwhile he has given, in his ninth *Pugillus Novarum et Minus Cognitarum Stirpium* (1851), a revised arrangement, with a complete catalogue and synonymy of all the species at present known, 193 in number.

Dr. Blume, the director of the Royal Herbarium at Leyden, having finished the *Rumphia* (in four folio volumes, with 213 plates) is making arrangements to resume his *Floræ Javæ*, which was interrupted in 1829, with the third volume. He also began in 1849, and continues in monthly fasciculi, each of 16 pages 8vo, the "*Museum Lugduno-Batavum, sive Stirpium Exoticarum Novarum vel minus Cognitarum ex vivis aut siccis brevis Expositio et Descriptio, additis figuris.*" Each number is accompanied by one plate, giving the detailed generic characters of from two to four plants. Different families or groups are taken up in succession, and more or less revised or monographed.

Professor DeVriese, who now has the botanical chair in the University, and the direction of the fine old botanic garden of Leyden, and Prof. Miquel, who holds the same position at Amsterdam, besides other important scientific undertakings, are working up the large collections recently brought by Junghuhn from the Dutch East India possessions, assisted by several collaborators (Mr. Bentham taking the *Leguminosæ*, etc.): the first fasciculus of the *Plantæ Junghuhnianæ* has already appeared, and probably the second also.

Drs. Dozy and Molkenboer, two physicians of Leyden, occupy their leisure with the Muscology of the Dutch Colonies.

Last year Sir Wm. Hooker, in conjunction with Professor Arnott of Glasgow, issued a new (the sixth) edition of the *British Flora*, which by the use of small type is brought down from the 8vo to a compact 12mo size. And Mr. Babington has this year brought out a third and revised edition of his *Manual of British Botany*. These two works ably represent the rival schools; the one strongly inclined to *combine and reduce*, the other to *distinguish* species.

Sir Wm. Hooker, although much absorbed with the direction of the noble botanic gardens at Kew, (which are on a scale worthy of the British nation, and which he has brought to a high state of perfection*) and with the editorial care of the *Botanical*

* Among the additions and improvements which have so changed the whole appearance of this establishment, that the visitor of twelve years ago scarcely recognizes the place, we should not omit to mention the great *Palm-house*, completed in 1848, in which the magnificent collection of palms and other large tropical trees and shrubs are now flourishing in all the freedom and luxuriance of their native climes. This structure is 362 feet in length, the central part 100 feet wide and 66

Magazine and of his *Journal of Botany*, has at length resumed the publication of his *Species Filicum;* part five, the first part of the second volume, having been issued last summer. It commences his fourth suborder, *Pterideæ*, (coinciding with the *Adiantaceæ* of Presl,) and is chiefly occupied with the genus *Adiantum*.

He has also resumed, with Reeve and Benham for publishers, his *Icones Plantarum*, which H. Bailliere threw up three years ago, at the close of the eighth volume. It is now issued in monthly numbers (at 2*s.* 6*d.*), each number containing eight plates. Even now it is doubtful whether it can be kept up, although the drawings are furnished on the stone gratis to the publisher, who has only to work them off, and print the small quantity of letter press required. But the sale of scientific periodicals, and indeed of most scientific publications in Great Britain, is inconceivably small. We must not forget Sir Wm. Hooker's magnificent publication brought out last spring, on the *Victoria regia*, in elephant folio, illustrated with four plates by Mr. Fitch, in a style worthy of the splendid subject. A new house is building for the Victoria at Kew gardens, with a tank large enough to show this gigantic Water-lily to advantage, and allow of its full development. A successful attempt has lately been made to flower this plant in the open air, at Chelsea, near London; the pond, however, being artificially warmed by hot water pipes; but this, as Mr. Downing remarks in the Horticulturist, would probably be unnecessary in the United States. Even at the north, our sultry summer's sun might heat a shallow pond sufficiently to bring well into flower vigorous individuals planted out in June or July.*

A second part of Dr. J. D. Hooker's superb *Rhododendrons of Sikkim Himalaya*, (illustrating ten more species,) was published last spring, about the time of the return to England of this ardent explorer and accomplished naturalist, from the field where he has been gathering so many laurels;—and even a third is now nearly ready.

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feet high; it is covered by about 45000 square feet of glass, all set in iron, and heated by 24000 feet of hot-water pipes, and a thousand square feet of tanks. And also the *Museum*, which the director has recently established, and which "is destined to receive all kinds of fruits and seeds, gums, resins, dye-stuffs, drugs, sections of woods, and all curious vegetable products, especially those that are useful in the arts, in medicine, and in domestic economy." This collection is rapidly increasing in extent and value; and it is already one of the most attractive and instructive portions of this great scientific establishment.

* Since this was written we learn that a plant has grown well in such a situation, in the kitchen garden of Mr. Cope, the president of the Pennsylvania Horticultural Society; but having been raised from the seed since the 21st of March, it was not sufficiently developed to flower this season. A plant of the same age, grown in a tank, kept at the proper temperature, opened its first blossom on the 21st of August. See *Downing's Horticulturist* for October.

Dr. Hooker has brought home vast botanical collections, as well as an immense number of drawings, &c. His former school-fellow, Dr. Thompson (son of the distinguished chemical professor at Glasgow, and his companion during the latter part of his exploration,) has also amassed an equally extensive herbarium in other parts of India, chiefly in the eastern Himalayan region. These, with the Wallichian and other herbaria, will serve as the foundation for the *Flora Indica*, which, should some aid be secured from the government and the East India Company, these courageous and excellent botanists propose to undertake. Meanwhile Dr. Hooker is already actively engaged with his *Flora Novæ-Zeelandiæ*, which, followed by the *Flora Tasmaniæ*, (both after the model of his *Flora Antarctica*,) will complete the botany of the Antarctic voyage under Capt. Sir James Ross.

When Dr. Hooker left England for India, he was engaged in working up the collections made by the lamented Dr. Vogel, in the ill-starred Niger expedition, under Capt. Trotter. The *Niger Flora* from the *Leguminosæ* onward was therefore elaborated by Mr. Bentham; and the *Spicilegia Gorgonica, a Catalogue of all the Plants as yet discovered in the Cape de Verd Islands*, with many important botanical details and characters, contributed by Mr. Webb; and the whole illustrated by fifty plates. A biography of Dr. Vogel, translated from the German of Dr. Treviranus, in the *Linnæa*, and his Journal of the voyage, up to the time of his fatal illness, preface the volume.

The directors of the East India Company are distributing among botanists copies of the journals and posthumous papers of the late Mr. Griffith, printed at Calcutta. Unfortunately the editor appears not to know enough of botany to correct the most obvious slips of the pen or mistakes of the press, nor to omit mere crudities and rough guesses, placed upon paper only to aid the memory, and obviously as unfit for publication, as are the occasional remarks, reflecting offensively upon other botanists. Two volumes of journals and itineraries have been issued; one on the development of organs in Phanerogamous plants; and one of notes on the development and structure of the higher Cryptogamous plants; each of the latter with a large quarto atlas of plates.

After an interval of four years a new part of the *Transactions of the Linnæan Society of London*, (part 3 of vol. xx,) has been issued. The greater number of papers, as is to be expected, are botanical. Prof. Arnott has a "*Note on Samara læta of Linnæus*, which proves to be a Myssinaceous plant, congeneric with Choripetalum. Mr. Miers contributes *a new genus of the order Burmanniaceæ*, with an arrangement of the family. Mr. Kippist describes "*Jansonia* a new genus of Leguminosæ," which proves to be identical with Cryptosema, *Meisn.* The late Mr.

Griffith has a paper on the *Structure of the Ascidia and Stomata of Dischidia*, and one *On the Impregnation of Dischidia.* These, with a paper *On the Development of Lemanea fluviatilis*, by Mr. Thwaites of Bristol, (now the successor of the lamented Dr. Gardner at Ceylon,) belong to the department of Structural Botany. Dr. Falconer describes *Athalamia, a new genus of Marchanticæ.* Dr. Planchon gives a detailed memoir *On Melianthеæ, a new natural order.* And finally Mr. Brown has published his account of that beautiful and perfectly preserved fossil fruit (*Triplosporite*, so called from the remarkable development of the spores in threes instead of fours,) which he has for several years past shown to those interested in such researches. If not identical, it is certainly very closely related to *Lepidostrobus*, which is thus demonstrated to be a Cryptogamous plant, allied to Lycopodium. An admirable paper of Dr. Hooker's on the structure and affinities of *Lepidostrobus*, we may add, which arrives at the same conclusion, may be found in vol. ii, part 2, of the *Memoirs of the Geological Survey of Great Britain*, accompanied by one *On the Vegetation of the Carboniferous period, as compared with that of the present day*, and another *On the Structure of Stigmaria.*

In Cryptogamic botany many new systematic works have appeared, and nearly all the orders have been newly elaborated.

We know of no proper *Species Filicum* in progress, except Sir Wm. Hooker's, already noticed.

The late Prof. Kunze's supplement to Schkuhrs Filices, (*Die Färnkrauter in koloriten Abbildungen*,) has gone only to the fourth fasciculus of the second volume, published last spring.

The *Synopsis Hepaticarum* by Gottsche, Lindenberg, and Nees von Esenbeck, gives full characters of all the species known up to 1847, when the last (fifth) part was published; the whole forming an 8vo volume of 834 pages. The genera, as well as the species are largely increased; and the former, 72 in number, are disposed in five tribes.

A similar work on the true Mosses, the *Synopsis Muscorum Frondosorum omnium hucusque cognitorum*, by Karl Müller, is by this time almost completed. The latest portion received (the third fasciculus of the second volume,) finishes the great genus *Hypnum*, of which 500 species are described.

The latest part of the admirable *Bryologia Europea*, with the authorship of which the name M. Gümbel is lately associated, is, I believe, the 42nd (1849). And Dr. Schimper has lately published in the *Mémoires de la Société d'Hist. Nat. de Strasbourg*, an elaborate paper on the anatomy and development of Mosses.

Kützing's *Species Algarum* (1849) has been followed, or rather superseded, by the much sounder *Species, Genera, et Ordines Algarum, seu Descriptiones succinctæ speciorum, generum, et or-*

dinum quibus Algarum regnum constituitur, by J. G. Agardh. The first part of the second volume appeared in July last. It is published at Lund, (Sweden,) and at Leipsic.

We should not forget here to state that the accomplished algologist, Professor Harvey, has completed the third volume of his admirable ***Phycologia Britannica***, which finishes the work. The 360 plates represent 378 species. A full synopsis of the orders, genera and species is appended, and new title-pages and indexes are given, arranged for binding the work either in three volumes, according to the order of publication, or in four, systematically, according to the synopsis of the species. The cultivators and amateurs of our science may be interested to know that Professor Harvey is now engaged upon his extensive memoir on the North American Algæ, to be published under the auspices of the Smithsonian Institution; and the plates of which promise to rival or excel those of the Phycologia Britannica, or of his *Nereis Australis*, which are so justly admired. The first part, containing the olive series of sea-weeds, is now in press. The new edition of his *Manual of British Algæ*, or rather a new work, the *Manual of the British Marine Algæ*, was issued by Van Voorst at the close of 1849, during the author's visit to this country. The genera are illustrated by twenty-six plates, after the manner of Dr. Greville's well-known *Algæ Britannicæ*.

Schærer's *Enumeratio Critica Lichenum Europæorum ex nova Methodo, &c.*, (Berne, 1830, 8vo, with 10 plates), is the latest and most important general work upon this order.

Art. VIII.—*Views on the Nature of Organic Structure;* by Lieut. E. B. Hunt, Corps of Engineers, U. S. A.*

Throughout the whole range of organic existence, both animal and vegetable, there is an evident adaptation of species and individuals to the particular circumstances in which they are found. Nor is it less true, that all animals and vegetables exhibit a broad general adaptation to the great cosmical and chemical peculiarities of the earth itself. The conditions indispensable for the existence of each organic species are such, that we cannot imagine its vital possibility except in its present astronomical *habitat*. Any great change from the earth's values for gravitation, the atmospheric pressure, the average heat and light, or greatly increased variations in these elements of condition, would prove fatal to all our present species. Nor could these species long survive a fundamental change in the atmosphere, the waters, the vapors, or the soils of the present terrestrial system.

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* Proc. Amer. Assoc., Albany, 1851. Sent to this Journal for publication, by the author.

The problem of conditions of existence, has an astronomical or cosmical phase. We can conceive a planet with platinum, gold, and silica continents, with a mercurial atmosphere, with elements whose combinations should be a hundred fold more refractory than ours, and yet with temperature conditions such that its aggregates of inorganic matter should be much the same as we now see. Moreover, we can conceive the existence there of vital organic forms, composed of elements wholly different from those entering organic bodies here, but whose functions should be performed exactly in conformity with earthly analogies.

How vastly unlike in physical features are this earth, Neptune, and Mars, yet some kind of organic life is, doubtless, actually existent on each. The structure of material forms, fitted to perform organic functions, involves an idea of the highest generality, and is mechanically possible in an infinity of material conditions. Either the organic form or the *habitat* being given or predetermined, an intellect sufficiently capacious could determine the other by *pure computation.* If to this intellect be superadded the power of giving material form or expression to these computed results, nothing more would be necessary for placing any conceivable organic type in its proper home, or in forming for any home its proper organic inhabitant. Man's intellect quite suffices to conceive how the Divine creative mind might infinitely vary organic forms in simple adaptation to their dissimilar homes throughout this wide universe. The historic order, in forming for all these varieties the terms of the existing relation between home and inhabitant, has been, seemingly, first to arrange the home, and then to construct the inhabitant. The species actually seen around us, embody the Divine solutions of those particular problems furnished by their specific physical circumstances. The range of variation in these circumstances over the earth's surface, permitted that immense variety of specific solutions exhibited by the known animal and vegetable kingdoms.

Certainly, natural science is falsely so called, when it ignores the intellectual character of organic forms. An optician who should attempt to investigate the eye without conceiving it as an intellectually composed organ, might labor forever in vain. The single way to comprehend its structure and mode of agency, is by carefully decyphering those ideas which are embodied and expressed in its forms and composition. Its one object is to form distinct images on the retina, and all its parts are composed with a strict view to the accomplishment of this object. A man who should study hieroglyphics, a locomotive, a telescope, a watch, or a book, in a spirit of mental negation and stubborn imperception of their intellectual origin, would not be more absurd, than one who sees no intellectual designing in the eye, the ear, the nerves, the skeleton, the whole organic frame. So far from its being unscientific to make a clear and positive use in natural research, of the intellectual character stamped on all organisms, it is simply self-inflicted blindness and deliberate paralysis to ignore those God-thoughts, actually embodied in each vital structure. The meaning and design of these structures are not less real than the matter composing them; just as the design and mental significance of a house are equally real with its materials.

A distinct conception of the intellectual arrangement of organic parts, in themselves, in their connections, and in their external relations, gives a clue to the physical nature of organic structures, such as no other view can give.

Inorganic masses of matter have an unlimited capacity to give expression to ideas, either without motion, as in the fine arts, or with motion, as in machinery of all kinds. In a locomotive, for instance, thousands of ideas, first existing only in the human mind, are materially embodied and formalized through this complex arrangement of parts, all of which act in designed relations. Functions of various kinds are performed in harmonious concurrence, exhibiting a partial semblance to vitality. Man's history proves, that were his intellect a hundred fold greater than it is, machines might be devised which would perform unimagined wonders. Every increase of intellect would give increased capacity to work ideas into material forms. A comparative machinist might, from a machine, infer the mental character and proficiency of its designer, just as a comparative anatomist makes out from the bones of an animal, all its habits. Any designed material structure reflects the intellect of its designer, and becomes higher in character with each exaltation of the designing mind. Were man's intellect to grow towards an infinite stature, where could we draw a limit to his capacity for giving material embodiment to his most advanced ideas? Would not his ever enlarging mind still clothe itself in material forms of proportionate subtlety in structure, function and design?

But man, in erecting material structures, deals only with masses. He has no power to build up his forms, by using at will, and in succession, *single molecules* of each chemical element. Were man's perceptions and capacities so microscopic that he could work with single molecules, and were his intellect sufficiently exalted, he might build up, in a purely mechanical mode, the exact similitude of any existing organic form, even that of his own body. Infinite intellect having wrought out the ideal of man's body, might thus materialize that ideal by simple arrangement of molecules, without the least change in any one molecule, or the introduction of any new mechanical element. To such a structure, the forces constitutional in matter would give coherence and stability. What more is required for conceiving the physical character of an organism, at a given instant of time?

Another step remains to complete our conception of the whole life of organic structures. What then is growth, and how is it to be conceived or explained?

The ideal of an organism extends through its entire cycle of being. The ideal of an oak is not the mere form of to-day, but that aggregate of formal progressions included between the acorn and the decaying oak. It includes provision for everything needed to insure its normal perpetuity. The history of an organic individual or species must always contain the two great elements of original constitution and circumstantial position. The specific ideal is inwrought and formalized in its constitution, while physical circumstances mar or exalt the development of this ideal. Unless an ideal were framed with a foresight of circumstantial influences, it must soon be frustrated. Now it is very possible to conceive how structures, intelligently composed from simple ordinary molecules, may be made to embody both static and dynamic ideals. The forces appertaining to the ultimate units of matter are quite adequate to work out ideals extending over the changes of a lifetime. In all organisms, the normal changes are progressive, and exemplify the law of continuity. This continuity extends unbroken through countless generations, always exhibiting strict conformity to mechanical requisitions. The wheel of specific life rolls steadily on, while its points describe the cycloids of individual life. A present structure may be so composed that the molecular forces acting between its constituent molecules, will of themselves work out a long train of predetermined changes. No matter how complicated the system of molecules may be, the determination of the orbit and movements of each molecule is a strict problem in mathematical mechanics, exactly the same in principle as that of planetary or projectile motion. The vast intellectual difficulty of the discussion does not affect its principle, nor would it obstruct a full predictive insight by a mind of sufficient grasp. Those differential worlds, whose integrals are seen in organic masses, move on, planet-like, in the round of their mechanically determined orbits.

That intellect which was large enough to idealize man, was, doubtless, large enough so to construct his body that the constituent forces of its component matter should operate the observed renovation and progression of its parts. In framing the ideal of which man is the embodiment, not only is it conceivable that the designing intelligence inwrought every mechanical essential for the physical functions of a full-grown man, but that a definite physical provision for all the changes in the whole cycle of his being was incorporated in the structure of his body. The individual cycle of growth, and the physical history of our race, from its beginning far into the unenacted future, may have been structurally embodied in the frames of our created progenitors and in the circumstances of existence surrounding them and their posterity. Thus, too, by direct design may the body have been made the structural depository of all those harmonies which alone can fit it to become the physical home of the spirit which inhabits it.

This mode of viewing organisms furnishes a hint as to instinct. A divine ideal would contain provision for all stages in the development of the individual. The activity of animal faculties is closely connected with, and mainly controlled by, physical structure, which, in all stages of development, must embody the necessary conditions for continued existence. In designing and framing an animal structure, the means for stimulating all the faculties required at each stage of its existence, would be introduced in its bodily constitution. Thus the operations, usually called instinctive, would result from a predetermined structure, specially designed to stimulate the particular faculties exercised. The materialized ideals would determine which faculties would be most active at each stage of growth and in each species of animals.

The views now presented are based entirely on the conceptions of matter and its constitutional forces, which inorganic masses constrain us to adopt. It cannot be too distinctly stated that every mechanical idea is outraged by the common conceptions of a peculiar "vital force" or "organic force." The term "force" has a definite meaning when used in mechanics, but no one can define a vital force. It is too mysterious, fickle, evasive, and illegitimate to permit a clear conception or definition. When an organic process is not understood, a vital force is usually summoned to remove our ignorance out of sight. Never was anything more purely hypothetical. Its parent is ignorance, smothering truth and investigation its office. Until some shadow of evidence is presented, that a special unmechanical force, peculiar to organic bodies really exists, we are in duty bound to abjure this convenient, this elastic figment of a vital force, which, "having no law, is a law unto itself." Though the complication of organic structure may forever prevent a strict mechanical analysis of organisms, we are not thus authorized to hypothecate a new force for convenience in cloaking ignorance. So far as we know, no molecule is ever moved, except by a real mechanical force, nor indeed can be, on account of its inertia. Though our muscles move in obedience to nervous impulses, the agencies applied are doubtless wholly physical below that point, so wholly mysterious, where the nerves centralize into one subtle thread of connection between the spiritual and material part of man.

This glancing into the depths of organic structure is no transcendental flight beyond the actual. Our appeal is only to that intelligence actually exhibited in formalizing the masses which compose organic studies. Let our conceptions but extend the sphere of this intelligence, to the intimate constitution of each organic mass, and we shall find a new light thrown on the whole nature of organic structure. It is true that every organism, on this view, is an embodiment of more subtle intelligence than all mankind can boast. But he must have studied nature quite in vain, who has not seen compulsory evidence that the organic architect is indeed great.

Art. IX.—*On the Municipal Electric Telegraph; especially in its application to Fire Alarms;* by William F. Channing, M.D.

The Electric Telegraph has two distinct offices. The first is to interlink distant communities, and to this its applications have been hitherto chiefly confined. The second which is hardly less important is to bring into coöperation the members or parts of single communities. Just in proportion as Civilization advances this application is to have a larger development. The Electric Telegraph is to constitute the nervous system of organized societies. For purposes of general intelligence and regulation, of alarm and police, the Municipal Telegraph, that is the Telegraph within the City or Town, has already numerous applications, which are of rapidly increasing importance. A single one of these, the application of the Telegraph to signalizing and communicating alarms of fire, with its incidental use for purposes of police, will be the subject of the present paper. The general conditions on which the security and uniform operation of the Telegraph, in all its Municipal applications, depend will also be considered.

At an early period in the history of the Electro-magnetic Telegraph in this country, the writer described its application to Fire Alarms, and published in the Boston Daily Advertiser of June 3, 1845, a general statement of principles which will be here more fully developed, and which are the basis of the System now in process of construction by the City of Boston. This is believed to have been the first publication in which the application of the Telegraph, not only to the purpose of simple signalizing, but also to that of giving public alarm in case of fire, was announced. Nearly ten years previous to this date, Professor Joseph Henry had devised an experiment, which, however, was not published until within the last two years, in which a distant bell could be struck by means of the release of a heavy weight suspended from his large electro-magnet,—the circuit of which, connected with a local battery, was opened by a small intensity receiving magnet operated by a long or Telegraphic circuit.

The Telegraphic Alarm System, subsequent to 1845, became the subject of occasional publication and its adoption was at length recommended by Hon. Josiah Quincy, Jr., Mayor of the City of Boston, in his official address of January, 1848. At this time Mr. Moses G. Farmer, Telegraphic Engineer, of Boston, directed his attention to the subject, and contrived his very beautiful secondary striking apparatus which will be hereafter described. Two models of this instrument were constructed for the City of Boston and were found to strike a large bell, with which they were connected, with certainty and precision. Sufficient confidence however, was not then felt in the Electric Telegraph, and the experiments were prosecuted no further by the City. In March of the present year (1851) I submitted to the City Government of Boston a detailed plan of the Telegraphic System of Fire Alarms, adapted to the conditions, geographical and otherwise, of the City, and accompanied with estimates of the expense of construction. In June, this plan was adopted, and an appropriation of $10,000 was made to carry it into effect. Mr. M. G. Farmer was appointed superintendent, and has contributed largely from his own resources to all subsequent adaptations and details of arrangement. The System now approaching completion in Boston, with the results of experience in its construction, will be described and illustrated in the course of the following pages.

During the present year the towers or belfries, seven in number, containing the fire bells of the City of New York, have been connected by a Telegraph wire, so that an alarm which had become known to the watchman in one, might be signalized to all the others. The indicating instruments used at these stations are of the most simple description, consisting of a small electro-magnet, armature and bell, with a local battery operated by a receiving magnet on the Telegraphic circuit. Accounts have also been received of the construction of a Fire Telegraph in Berlin by M. Siemens, Lieutenant of Engineers, but whether confined as in New York to simple signalizing, or connected also with automatic apparatus for public alarm, does not appear. The same Telegraph wire is described as connecting electrically the public clocks, or rather dials of Berlin, by a similar application of the electro-magnet, apparently to that made in this country three years ago by Mr. Farmer, to which reference will be made in another connection.

The Electric Telegraph in its common use, or as commonly regarded, is an agency for the transmission of intelligence or impressions to a distance. In this its functions are analogous to the sensitive nerves of the animal system. The Electric Telegraph, especially in its Municipal uses, may superadd to this the production of important mechanical effects, either by its own electro-magnetic energy, or by calling into action other machinery.

The analogy here with the functions of the motor nerves and apparatus of the animal system is equally strict and important. In any system of Municipal organization in which it is attempted to supply a living bond by means of the Telegraph, the distinction between these functions must be recognized; and in any system in which it is desired to employ both of these, to obtain unity of action from a variety of parts, it is necessary that the analogy furnished by the animal system, should be preserved in the relation of these functions. In other words there should be a Centre to which all impressions from the circumference or extremes should first be conveyed over one set of conductors, and from which after an act of intelligence, the impulses to corresponding action should proceed over another. Here is the brain and nervous system of the animal or of man. The Telegraph when employed for any office of social organization of a high order must conform to the same analogy.

As a first condition of the Fire Alarm Telegraph, we have therefore an Electric Centre, where the batteries and certain instruments, with a single operator, are placed,—and two classes of circuits or conductors, one of them *afferent*, *sensitive*, or "Signal," by which the intelligence of a fire is communicated to the Centre, the other, *efferent*, *motor*, or "Alarm," by which the impulse is sent out to the machinery by which the alarm-bells are struck.

The arrangement and security of the Conductors is a subject of primary importance in all applications of the Municipal Telegraph. As a first remark then, experience shows that a simple Telegraph wire, stretched across a City over the house tops, is more certain and reliable as a means of communication in the variable conditions of weather, season, and crowded thoroughfares, than any system of intercourse depending upon sight, sound, or transportation. To illustrate this, the wires of the House Telegraph, extending over a mile through the City of Boston, were interrupted only twice in the course of a year and a half, having been broken both times by snow falling from the eaves of houses, beneath which they had been improperly placed. The Bain wires during the same period, had been broken only once, and then by workmen engaged in building a house with which they interfered. When it is considered that the wires are an open channel of communication by night as well as by day, it will be conceded that no such immunity from accident can be found in any other system, at all commensurable in its functions with the Telegraph. There are however many important safeguards in the erection and arrangement of Conductors in the City, by which the security from interruption of Electric Circuits may be rendered almost absolute, and these will now be considered.

The Conductors commonly used consist of iron wire, supported by insulators upon the houses. These wires, where erected with a view to permanence and stability, should be of the best Swedish iron, and be limited in size and strength only by the strength of the supports which it is practicable to employ. The largest iron wire in common use within our cities is No. 9, which weighs about 325 lbs. to the mile. The construction of the Alarm System in Boston, was commenced with wire No. 8, weighing about 400 lbs. to the mile. It was found however that the brickwork would not often hold the insulators, with the weight of so heavy a wire, without the intervention of brackets of unusual strength, into which the insulators were screwed. In the South Boston Circuit, wire No. 10, weighing rather less than 300 lbs. to the mile, was employed, as giving on the whole greater security, without exceeding very much, by the mode of support, the usual cost of such works. The length of the wire in the Municipal Telegraph of Boston is about 49 miles, and it has probably been erected with greater care and thoroughness than any similar structure in the country.

In a System, however, of such public importance, and designed to be permanent in its character, no effort should be spared to give a massive strength to every part, and ample provision should be made for the careful and judicious survey of routes and selection of the places of attachment for the wires. It is also to be considered that a structure liable to frequent derangement, would be a source of just annoyance to real estate holders in the City, whose buildings are needed for the support of insulators. For these reasons, Mr. Farmer would recommend the appropriation of $150 per mile for the conductors of the Municipal Telegraph, so as to allow the use of large and often elevated brackets, supporting No. 8 wire in carefully selected positions. This is a more elaborate method of construction than has yet been attempted. The wire of the same size, erected in Boston, has cost about $73 per mile, and should possess great strength and stability after it has been tested by exposure, and any weak parts have been replaced.

In the selection of buildings for the support of the Conductors, public edifices, such as churches, school houses, &c., should be preferred, and next to these, lofty and isolated buildings, in order to remove the wires, as much as possible, from danger of interference. Two wires, or, at least, related wires, should not be attached to the same building or block of buildings. The Conductors should be so much elevated above the roofs of houses, that their insulation should never be impaired by contact with fallen snow.

The stretches of wire, in the Municipal Telegraph, should be as long and few as practicable, consistent with security, in order to avoid loss by imperfect insulation, and the multiplication of places of support, where alone, interference with the wires is possible. In Boston it has not been considered prudent to extend the stretches of the Alarm System generally over two hundred feet, on account of the occasional storms of snow and rain in the winter, in which great accumulations of ice are formed upon the wires. A single stretch however of the House line, of over 800 feet between the towers of neighboring churches, has continued undisturbed for two years. In cities in this country South of Boston, stretches of 300 or 400 feet may be allowable.

From the strength of the conductors they can not be easily interrupted either by accident or design, and in the latter case recourse must almost necessarily be had to instruments. The place of such violence would be apparent, and the broken wire, from its weight and tension, would fall at once to the ground. Detection would therefore be easy. The wires, used for an important public object, would, of course, be protected by law. The police and members of the fire department should be instructed at once to report a broken wire that it may be repaired.

As the interruption of a wire is a possible, though not a probable or frequent occurrence, the principle of Double Conductors must be introduced into any System, in which absolute uniformity of action is required. This is necessary in the chronometric application of the Telegraph, where electric pulsations are sent over the wires every second to measure and mark uniform time on a hundred dials. It is equally necessary in the application of the Telegraph to purposes of public alarm where reliance is placed on the unerring certainty of its operation in a sudden emergency. Hence, between each station of the Fire Alarm System, there are two conducting wires following different routes. A proportionate increase of conducting power is an incidental advantage of this use of two-fold wires.

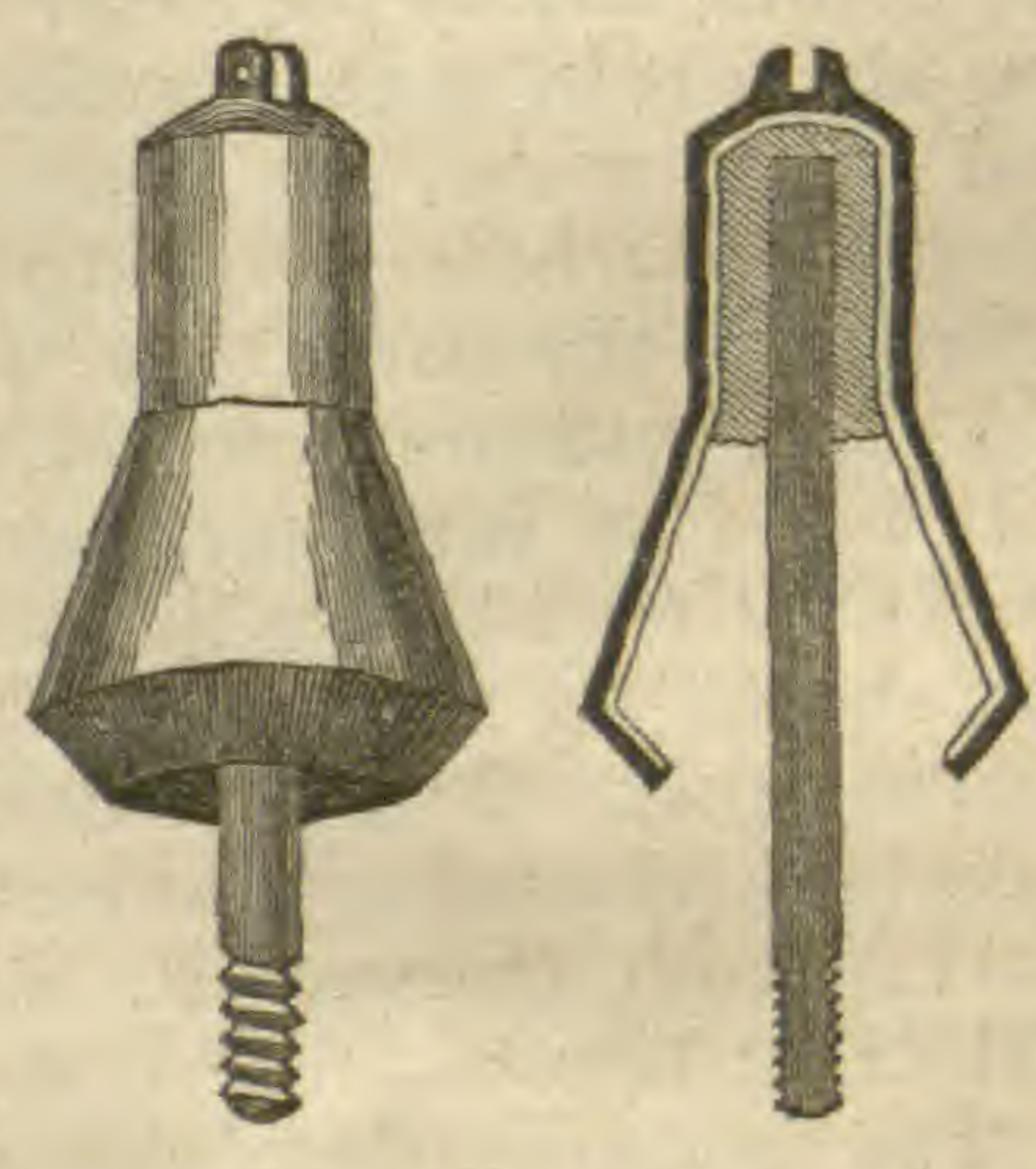
By a strict regard to the principles of construction and arrangement, which have thus been considered, *the interruption of the circuits of the Municipal Telegraph becomes practically impossible.*

The ground can not be used as any part of the circuit of the Municipal Telegraph without introducing a source of irregularity. A connection, accidentally or intentionally made between the wire and the ground, in such case, would complete an "open" circuit, or throw part of a "closed" circuit out of use. A duplicate conductor would also cease to be an advantage or security, where the circuit would be permanently completed by the interruption and falling of a single wire to the ground. In the Fire Alarm System, the circuits are composed exclusively of wires, and these, in the process of erection, are separated as widely as possible, especially in the case of corresponding wires, whose cross-connection would complete a circuit. Between the different Stations the wires diverge widely, and at Stations where they may come together for the purposes of signalizing, they are carefully protected. Hence *false alarms*, by an abuse of the wires, are rendered nearly impossible.

Another important result from the exclusive use of wires is *double insulation*. If the ground were used there would be only one insulator between it and the wire above, forming part of the same circuit, but, with wire conductors alone, there are two insulators, besides the buildings and intervening ground, which the current must traverse to make the circuit complete between corresponding conductors. Another useful result of the same arrangement is that the ground is left as a reserve, and can be used temporarily with a separate battery for special police communications, in connection with, or addition to, both of the Signal wires.

As the insulator forms an important part of every Telegraphic System, the form used in the construction at Boston, which is Batchelder's patent, is shown in fig. 1. The cast iron cap is represented by the black line in the section. This is lined throughout with glass, by the operation of blowing, or with porcelain. The shank is then introduced with a hot mass of glass, or any fused or semi-fused material, by which it is firmly fixed in its place. This is represented by the shaded portion. Between the lower edge of the cap and the shank, in the section, there are four inches of glass surface. The reëntering angle of the lower part of the cap protects the glass within from missiles, and is calculated in a storm of wind and rain to drive the latter downward, and thus preserve the insulation. The wires pass over the top of the insulator. The shank, which should be longer than is represented, screws into a bracket or the ridgepole of a house.

1.



From the difficulty of always obtaining suitable places of support in cities for the conductors carried through the air, the use of insulated wires, buried in metallic tubes, may be resorted to sometimes with advantage, in the Municipal Telegraph. By sinking the tubes beneath the reach of accident or frost, great security may be obtained, but with a great increase of expense. Thus the cost of insulated conductors, laid underneath the streets of cities, may be estimated at from $600 to $1,000 per mile.

To ensure regularity of action as well as for purposes of safety, Dischargers of atmospheric electricity have been provided at every

Signal and Alarm Station of the System in Boston, numbering sixty in all. These were constructed by Mr. Farmer, on the principle of conducting to the earth all free electricity, or electricity above a certain degree of tension, and will be figured hereafter. So large a number of these, employed in connection with the circuits of forty-nine miles of wire, above the buildings, can not fail to exert an important influence in silently discharging accumulations of atmospheric electricity. A general protection against danger from this source may thus be incidentally afforded by the Municipal Telegraph.

In a perfect system of Fire Alarms it is necessary that communication should be *instantaneous*, *universal* and *definite*. The Electric Telegraph, by its peculiar properties, affords the means of fulfilling all of these conditions. Its pulsations are transmitted in an inappreciable time over the wires of the Municipal circuit. By the multiplication of Stations in the course of the Signal wires, by which all parts of the City are brought into communication with the Centre, and by the electro-mechanical connection of the various alarm bells with the Centre, the means both of signalizing and public alarm, are made universal. By the use of electro-magnetic machinery, by which District Signals may be struck or tolled upon the alarm bells, at will, the System becomes definite.

In the communication of a definite alarm, the division of a City into Fire Districts becomes necessary. These will vary in each City according to its size and other conditions. The number should be sufficient to localize a fire without unnecessary complication. The following are the District Divisions which have been adopted in Boston: I, North,—II, West,—III, Centre,—IV, South Centre,—V, South End,—VI, South Boston,—VII, East Boston.

The fundamental division of Circuits into those of Signal and Alarm has already been stated; the one conveying the intelligence of a fire from the Signal Stations to the Central Office,—the other, communicating the impulse to mechanical action from the Central Office to the bells. As the completion or interruption of the Circuit is the condition by which the effects of the battery are obtained in the Telegraph, the Signal Circuit is so arranged that it can be completed or interrupted by means of a Signal Key or Signal Crank at any of the Stations, which are distributed at suitable intervals throughout the City. In fig. 2, the arrangement of the Signal wires with an open circuit is shown. B represents the battery, p and n its positive and negative poles. It will be seen that a conductor starts from each pole, and following the course of the circuit, returns to its point of departure. S, S, S are three Signal Stations. The battery circuit may be completed by the depression of either of the keys K, K, K, or of one of any number of keys similarly situated between the wires. It will be observed that either or both of the wires may be broken in a single place, and yet every Signal Station will be in communication with both poles of the battery, following the conductors round in one or the other direction. By this arrangement, therefore, the principle of double conductors is preserved. As an additional safeguard, the interruption of either of the wires in a single place would be known at the Central office within an hour, by means of testing apparatus. The wires will be seen to diverge between the Stations, taking routes widely separated. At

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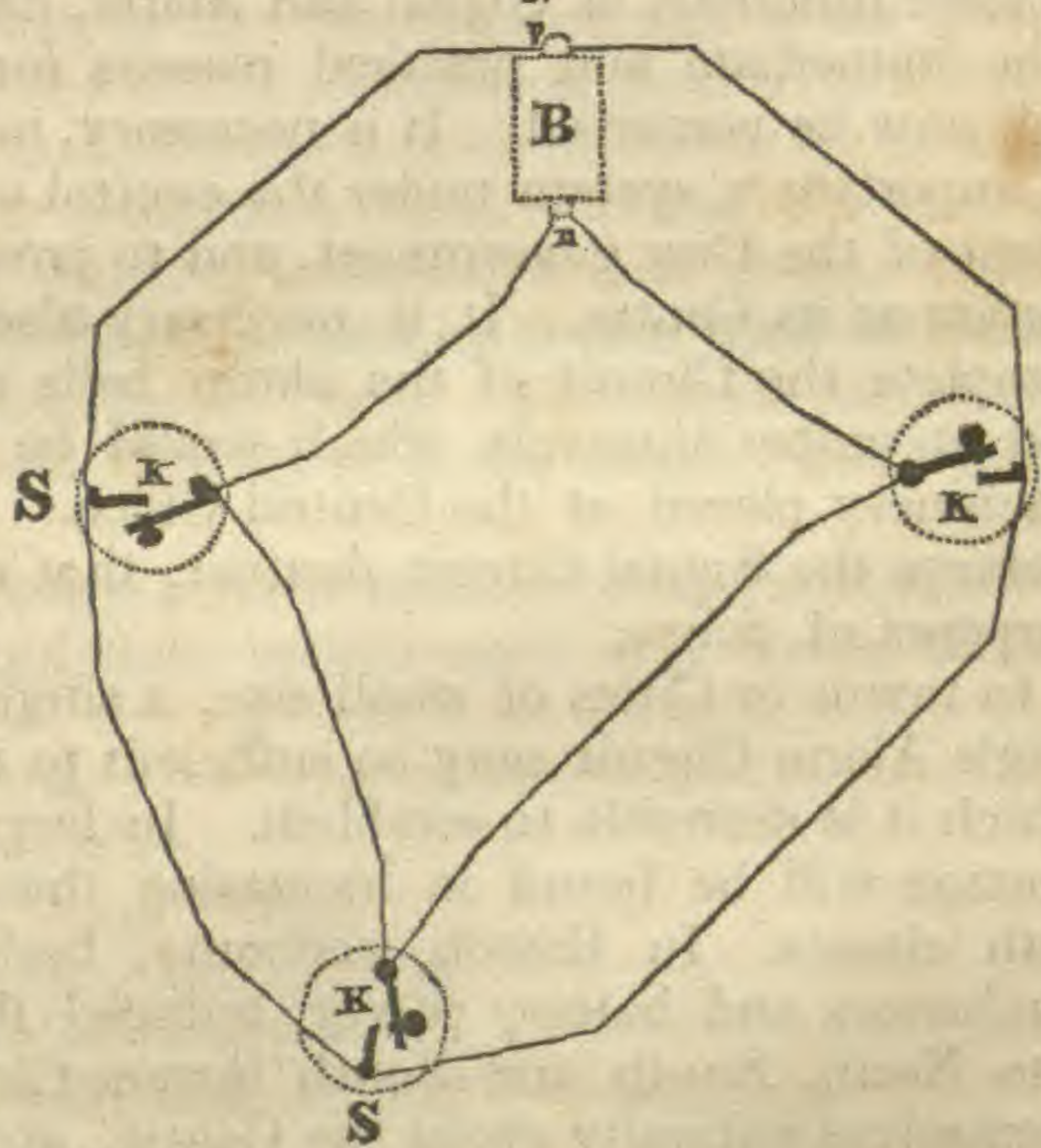

the Signal Stations themselves where the wires approach, there is the possibility of a cross connection, if the open circuit is used. The building selected for this purpose should therefore be isolated or have a roof as little accessible as possible. This difficulty is obviated by the use of the closed circuit. In this case, depressing the Signal key would break instead of completing the circuit, and the wires would be arranged between the Stations like the links of a chain, as in fig. 3. Owing to the difficulty of keeping the wires sufficiently separated in all parts of the System in Boston, and the occasional use of posts, as in crossing the South Boston bridge, the closed circuit will be partially if not altogether used with the Signal wires.

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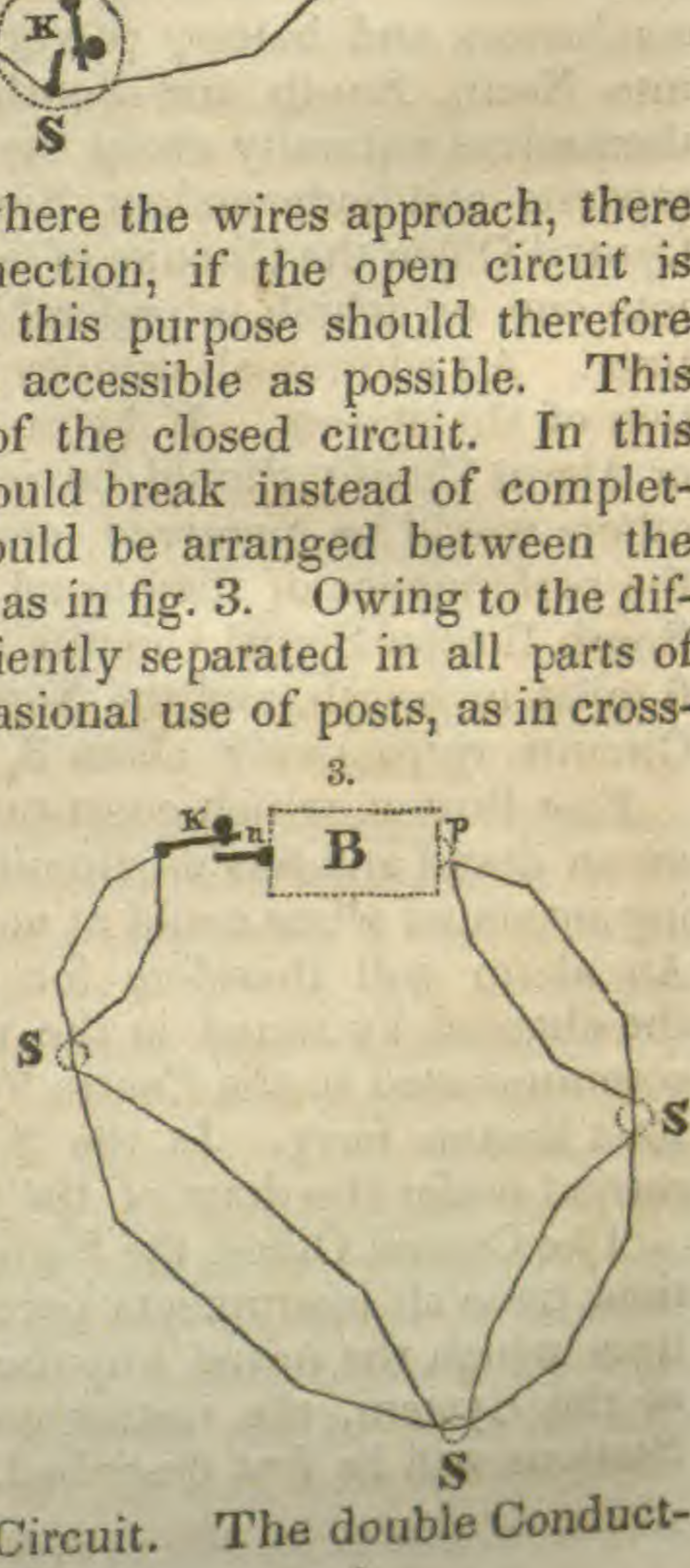


The Alarm Circuit is so arranged that it may be completed by depressing a key at the Central Office. In fig. 3, B represents the battery at the Central Office, and K the Alarm Key. S, S, S, are Alarm Stations, such as churches, where the machinery is placed by which the bell is struck when the Circuit is completed. Several of these may be included in the same Circuit. The double Conductors are seen diverging between the Stations, at which they unite in a single wire.

The general grounds for the division of the Circuits, according to their functions of Signal and Alarm, have already been stated. The immediate and practical reasons for such an arrangement will now be perceived. It is necessary, in the first place, to have so important a system under the control of some department or agent of the City government, and to provide for intelligent direction at its Centre. It is necessary also to provide means to complete the Circuit of the alarm bells with perfect regularity and at proper intervals, which would be impossible, except by machinery placed at the Central Office. It is also important to preserve the Signal Circuit distinct, that it may be available for purposes of police.

In towns or Cities of small size, a single Signal Circuit and a single Alarm Circuit may be sufficient to include all the Stations which it is desirable to establish. In larger cities however, advantage will be found in increasing the number of Circuits of both classes. In Boston, economy, both as regards length of conductors and battery power, induced the division of the City into North, South and South Boston Circuits. These arrange themselves naturally about the Centre, and each division has its separate and independent Signal and Alarm Systems. At the Central Office the Circuits of a similar class may all be connected into one, or, which is preferable, they may be kept entirely distinct. An additional security is thus obtained against interruption of the system. If by an improbable chance a single Signal or Alarm Circuit should be interrupted, the integrity of all the others would be preserved, and they would still be available for the performance of their usual functions. The North, South and South Boston Signal Circuits are respectively about 3¼, 4¾ and 6 miles in length, and the North, South and South Boston Alarm Circuits, respectively, about 3, 3½ and 4 miles.

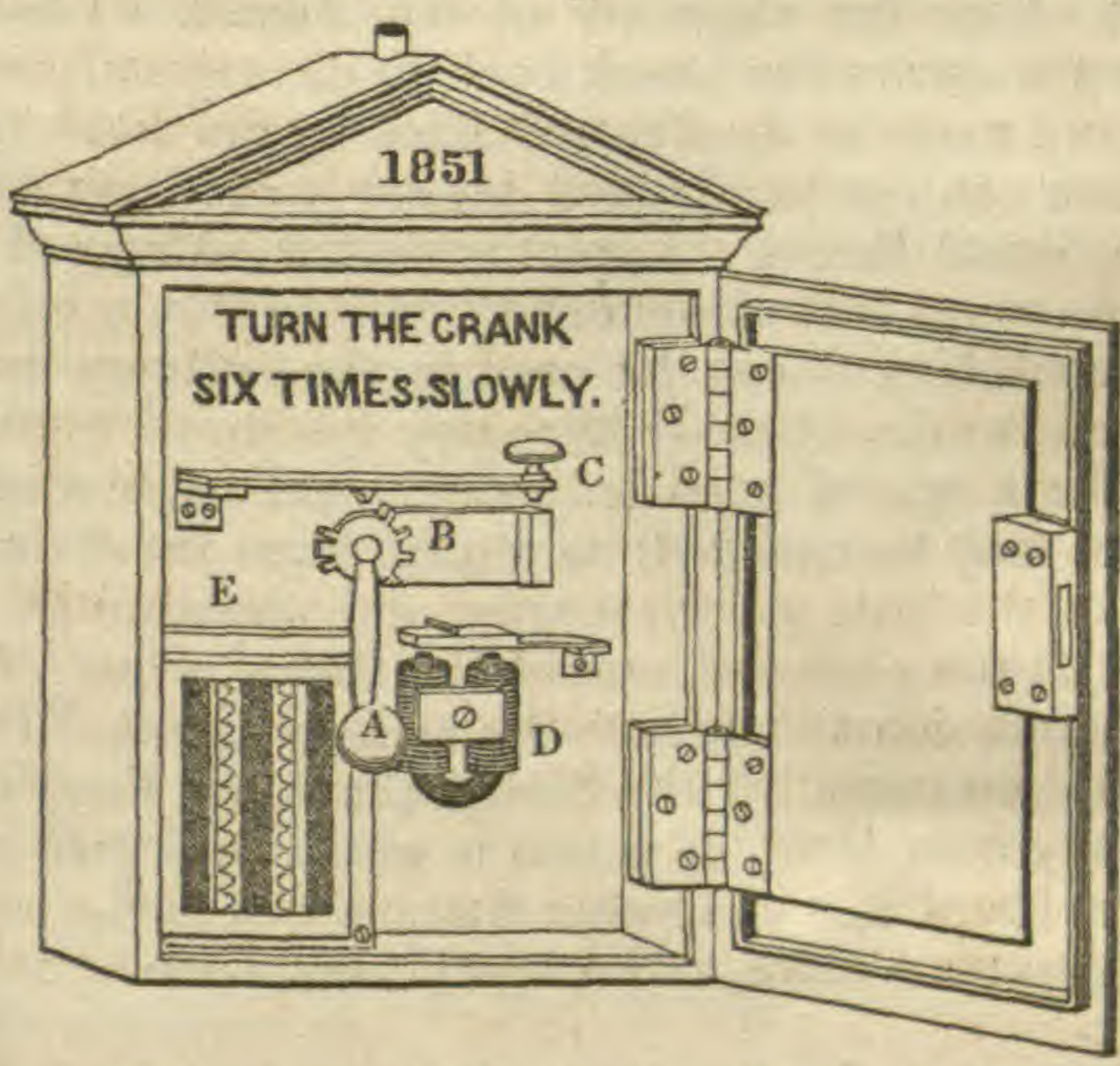
East Boston, which constitutes the Seventh District, is situated on an island and has no circuit of its own, though a pipe enclosing insulated wires could at any time be sunk under the channel. An alarm will therefore for the present, be signalized across the channel by sound in the usual manner, and will thence be communicated to the Centre by a special Signal Station near the East Boston ferry. In the South Boston Circuit the wires are carried under the draw of the bridge, enclosed in a pipe.

The Central Office, the Signal Stations and the Alarm bell Stations have all instruments peculiar to themselves. As the point from which the initial impulse proceeds in the actual operation of the System, the instruments and connections of the Signal Stations will be first described.

The Signal instruments are contained in a strong cast iron case, and connection is made between this and the Conductors on the top of the building by a wrought iron pipe enclosing insulated wires. Entire protection to the instruments and wires is thus obtained. The Committee of Construction in Boston have wisely decided to place these boxes on the outside of buildings, in places well selected, generally opposite a lamp. These Stations are distributed throughout the City at distances not greater than a hundred rods from each other, so that no house shall be distant more than fifty rods from one of them. Thus there are 18 Signal Stations in the North Circuit, 16 in the South, and 7 in the South Boston Circuit.

The Signal Box, belonging to the Boston System is represented in fig. 4. The box and door consist each of a heavy casting.

4.



The hinges and lock are of the most substantial kind. The outside of the door has upon it the words Signal Station, with the number of the Station, and a panel containing a notice of the place where the key is to be found, and perhaps also an extract from a City Ordinance for the regulation and protection of the System. The Signal Crank with a heavily weighted handle is seen within the box at A. It was devised by Mr. Farmer and myself, to obviate the irregularity which might arise from the manipulation of the Signal Key by ignorant or incompetent persons. The axis of the crank carries a circuit wheel B provided with a number of teeth or cams, each of which, in revolving, completes the circuit momentarily by a sliding contact with the key C. These cams are divided into two groups, seen in the figure, one on each side of the circuit wheel, the principal of which groups numbers from one to seven cams, according to the number of the District in which the Signal box is placed. This communicates the District number to the Central Office. The other group consists of from two to four cams, placed closely together, and so formed as to complete the circuit for longer or shorter periods and produce a record at the Central Office, of dots and lines, indicating the number of the Station. The box contains instructions to turn the crank six times. The effect of this, with the Crank represented in the figure, would be to communicate the Signal of the Fourth District, alternating with that of the fifth Station, (a dot, a line and a dot,) six times in rapid succession, to the Central Office, where it would be indicated and registered by proper machinery. The object of the repetition of the Signal is to draw attention and ensure its correct reception. A different number of revolutions of the Crank or its rapid rotation would not affect the character of the Signal. The weighted handle always carries the Crank back to its original position.

The record made at the Central Office by the revolution of the Signal Crank can not be imitated by any person not having access to the Signal Boxes. A great additional safeguard from any abuse of the wires is thus obtained.

The Signal Key C can be used in the ordinary manner, to communicate to the Central Office any system of Signals which may have been agreed upon for police or other purposes. Communications may be received, in return, from the Central Office, by means of the little electro-magnet and armature D, which is introduced in the course of one of the Signal wires. The click of the armature constitutes here the audible signal. This would also be heard on operating the Signal Crank or Key, if the circuit was duly completed, of which it would thus give indication. It would be heard also if another Station was in the act of communicating to the Centre, and it would thus prevent confusion in signalizing.

The Discharger of atmospheric electricity is represented at E. It consists of three strips of brass, resting on varnished wood and covered with a glass plate, with strips of India rubber cloth interposed. The central strip communicates with the ground and has serrated edges which are presented in close proximity to the strips on each side. These strips communicate each with one of the Signal wires. Any free electricity or any intense charge of induced electricity in the wires would thus be discharged, by means of the sharp edges, offered by the ground conductor.

Where the closed circuit is used, the instruments in the Signal Box would undergo a very slight change. The Signal Key would complete the circuit by contact, when at rest, and would break it when depressed by the cams. The electro-magnet D would be included constantly in the circuit, and the click of the armature would be heard on its release, when the Circuit was broken.

The instruments in the Signal Box are attached to a false back of wood, behind which the communicating wires are disposed. The socket for the reception of the wrought iron pipe containing the insulated conductors, is seen on the top of the box.

Each Signal Station is in charge of a person or family in the immediate neighborhood, whose duty it is to open the Box in case of an alarm and turn the Crank. This act is so simple that it might be performed by a child. Certain members of the Fire, Watch and Police Departments, are also provided with keys to the Signal Boxes. The object to be secured in this arrangement, is abundant access to the Signal Apparatus in case of fire, and yet a sufficient guarantee against its abuse. A periodical report should be required from the agents in charge of the Stations.

Connection may at any time be made between the ground conductor of the electrical Discharger and one of the Signal wires, for the purpose of special Signalizing to the Central Office, without the indication of the signals at any intermediate Station.

The Centre of the System in Boston is established in the City Building adjoining the City Hall. From its roof which is isolated, the wires, elevated on a bracket, radiate in all directions.

The instruments at the Central Office are in part receiving and in part transmitting, besides the batteries for the whole system, and the testing and registering instruments employed in the regulation of the Circuits.

The receiving apparatus consists of an Office Alarm for each of the three Signal Circuits, and a single electro-magnetic Register, of the Morse construction, with which they communicate in common. The Alarm is represented in fig. 5. It is a simple electro-magnet, with an armature attached to the upright lever which carries the hammer. The bell is of large size. For the purpose of obtaining a powerful blow from the hammer, sufficient to rouse any one sleeping in the Office, it may be operated by a local battery with a receiving magnet interposed between it and the Signal Circuit. The Office Alarm with the local circuit ar-

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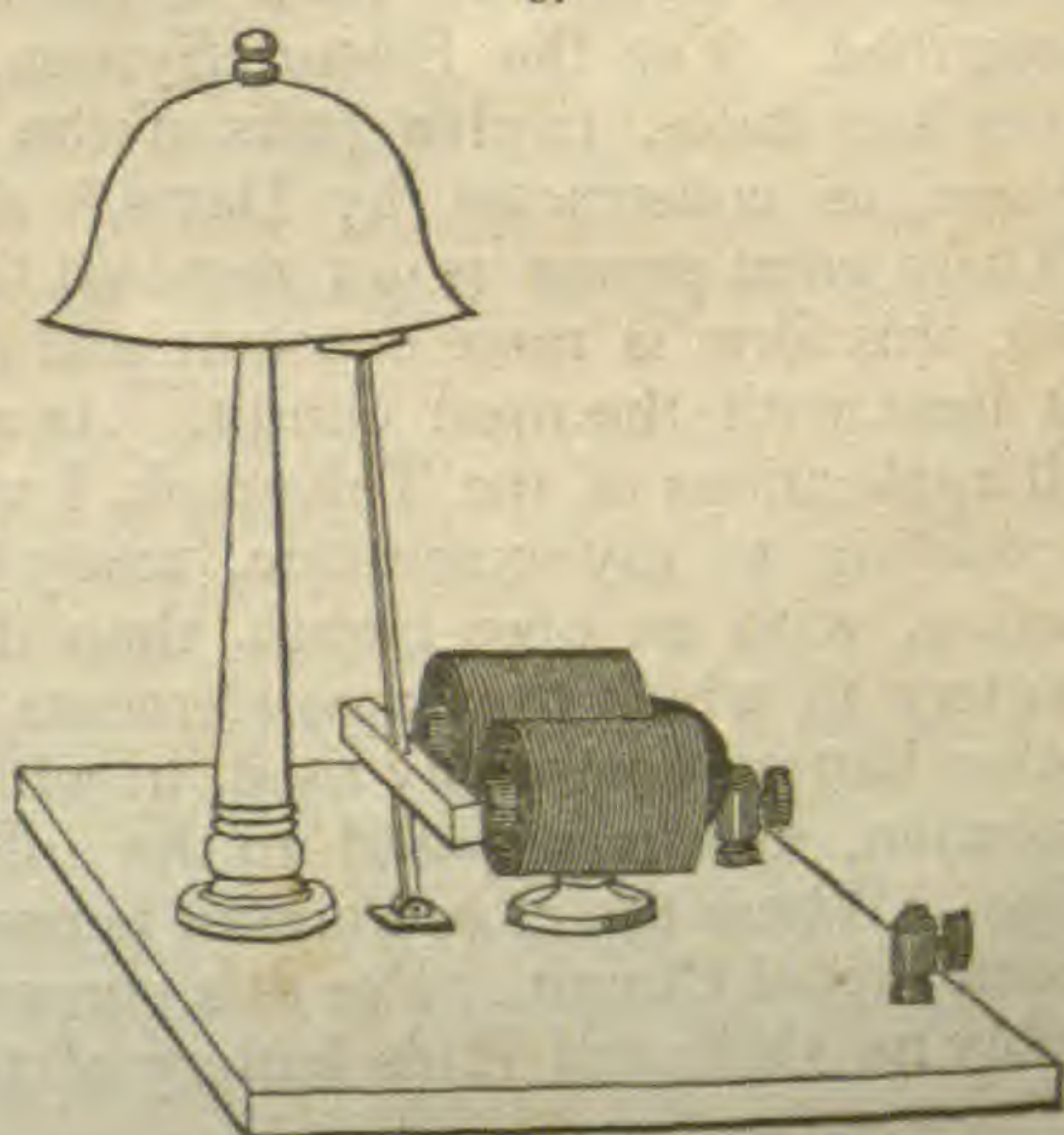


rangement, is an apparatus identical with one figured in Cooke and Wheatstone's English patent of 1837, to which I take pleasure in referring it.

The Register used is the common electro-magnetic register, arranged so as to start and stop itself. It is made to run faster than usual, so as to record legibly the Signals made by the Signal Crank, even when turned rapidly. The Register may be operated by the same local circuit as the three Office Alarms. A Switch is provided to disconnect the Alarm of any Circuit, when the Register is used for continued communication. The Alarms connected with the different Circuits are provided with bells of different tone, so that it is immediately perceived, by the sound, from which circuit any Signal proceeds.

It is often desirable to send a communication back to the Signal Stations for purposes of police, or, it may be, to inform an officer of the Fire Department of the number of the Station from which an Alarm of Fire has been signalized. For these and similar objects, a Key like that which will be described in connection with fig. 8, is placed at the Central Office, in the course of the Signal wire which embraces the little electro-magnets in the Signal boxes; or, if a closed circuit is used, a simple break-circuit Key is introduced in each Signal Circuit. Thus the number of a station signalizing an alarm of fire, or any other Signal, may be counted out, in answer to an enquiry, upon the electro-magnets in all the Signal Boxes of a Circuit, by the Agent or operator at the Central Office.

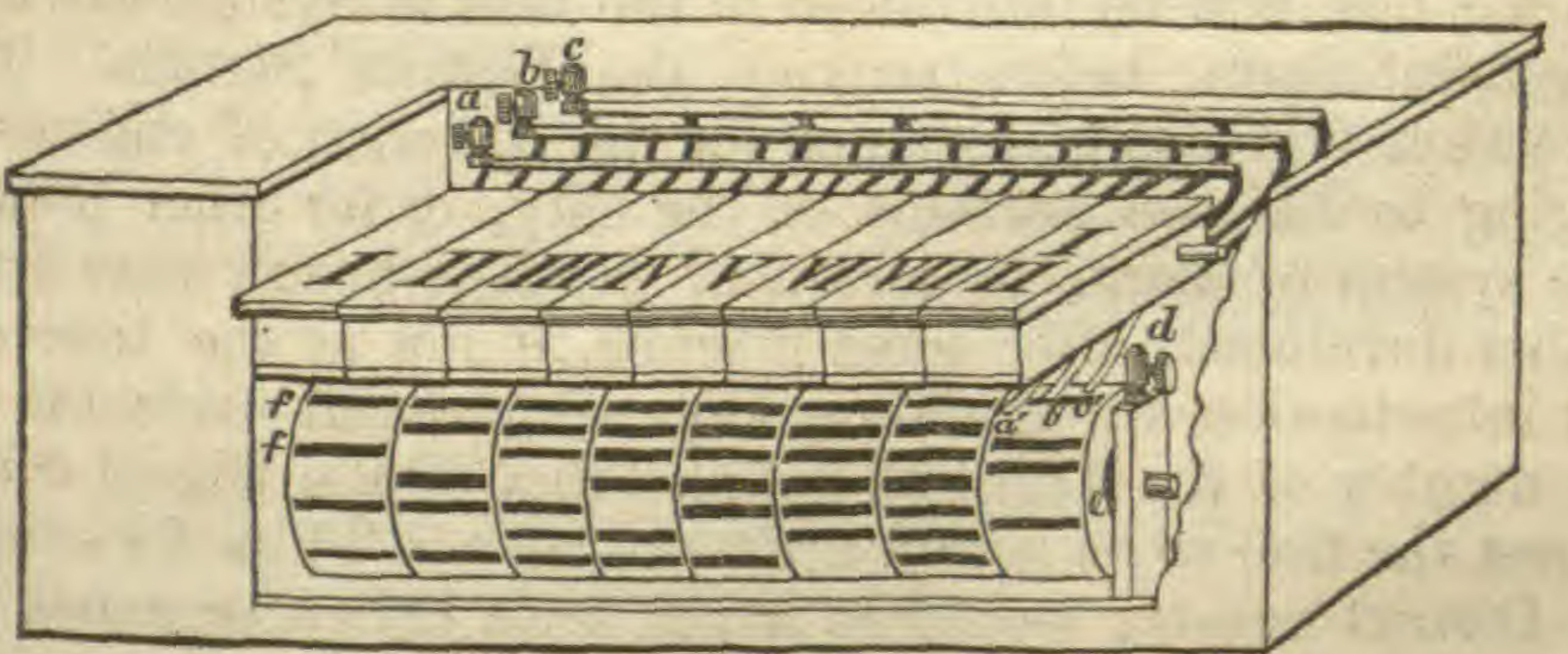
The Signal Battery may be common to any number of open Signal Circuits, the extremities of each Circuit being connected with its poles as shown in Fig. 2. The same battery may also be used for signalizing back to the Stations in the manner just described. For the Boston System, and with Circuits of not over six miles, twelve pairs of the Odds and Ends battery of Smee, as constructed by Davis,* should be amply sufficient. Where great power is not required from a battery for telegraphing, this form is more constant and manageable than any other, at least with the open circuit. As a fact of general interest in all applications of the Telegraph, I will state that this battery is, according to my experience, many times more enduring in its action, with an open circuit, than the common form of Smee's battery in which the same elements are employed, or than any other battery commonly used, in which the zinc rises above the solution, and is exposed to the influence of the air and water line. Where the closed circuit is used, a battery is necessary for each Signal Circuit. For this purpose a Daniel's battery or possibly an Odds and Ends battery of twelve pairs may be applied.

* Davis's Manual of Magnetism, 2nd edition, p. 56.

The transmitting apparatus, connected with the Alarm Circuit, consists of a common Signal or rather Alarm Key, and of the District Keyboard. The purpose of both these instruments is to complete at suitable times the circuit, by which the machinery at the Alarm Stations is thrown into action.

To obviate the difficulty of completing the circuit by the Alarm Key, with the absolute regularity necessary to strike the District Signals upon the bells, the District Key-board is introduced. This instrument, which in its simple form was early employed in the Telegraph, is represented in fig. 6. The Keys, with

6.



one exception, are seen marked with the numbers of the Districts. Below the Key-board is a cylinder, which is moved by clock-work at a given rate when the instrument is in operation. The cylinder is of wood having a metallic core, *e*. Strips of metal, *ff*, connected through with the core, are set into the wood of the cylinder, so as to form groups under the several Keys, equal in number to the District Signals, marked upon them. Thus, under the Key of District One, single strips widely separated are seen, under the Key of District Two, two strips, and after a considerable interval, two more, and so on. It is obvious, with this arrangement, that if each key should bring a conductor to bear upon the surface of the cylinder beneath, it would complete electric communication through to the core, at regular intervals corresponding to the District Signals.

For the sake of economy of battery power and the security of distinct circuits, it is desirable to throw the force of the Battery upon the three Alarm Circuits separately and in succession. This is effected by attaching three metallic springs a', b', c', to the under surface of each key. These springs when the key is depressed, bear upon the cylinder in an oblique line, that is, a' in advance of b', and b' in advance of c'. The other extremities of these springs make an ample bend behind the Key-board, to allow freedom of motion to the keys, and are then fastened respectively to the metallic bars *a*, *b*, *c*, the corresponding spring of each key being attached to the same bar. Now on depressing any key, the strips of the revolving cylinder come in contact with the three springs in succession, and if the Alarm Circuits are each connected at one extremity with the three screw cups *a*, *b*, *c*, and at the other, through the Alarm Battery with the screw cup *d* and core *e*, the current is thrown on to each of these circuits in quick succession, and at intervals corresponding to the number of the District marked upon the key.

The figure is represented with seven District Keys, and an eighth, intended for the Signal "All Out," the use of which will be described hereafter. The number of the keys may be increased at pleasure. A key for fast striking, that is once in about two seconds, will be introduced in the Boston System as a means of general alarm, before striking the District Signals. Three spare keys will also be assigned for the direction of engines, belonging to different sections of the City, or for other purposes. The system of alarm, by means of the Key-board, may also be further developed, after some practice, if not at the time of its first introduction, by providing keys which shall cause not only the number of the District, but also that of the Signal Station, nearest the fire, to be struck upon the bells. Thus for example, the District number would be struck with blows, separated from each other by an interval of two seconds; then a pause would intervene of four seconds; then the number of the Station would be struck with blows having an interval again of two seconds; and finally a pause of eight seconds would follow before the commencement of another Signal. With a key for each Station, in addition to those for other purposes, this would require in Boston a Key-board of forty-eight keys.

The clock-work which carries the cylinder is not shown in the figure, but it can be regulated so as to give any interval which may be desired or may be necessary between the strokes of the alarm bells. The keys are so arranged that the depression of any one liberates the clock-work and sets the cylinder in motion, and the subsequent release of the same key stops the clock-work at the end of one revolution of the cylinder. While the key is held down the electric impulses continue to be sent out at measured intervals over the wires.

It may often be desirable to confine an alarm to only one or two of the Circuits. This is easily effected by a Switch placed upon each Circuit, so as to shut it off at will from connection with the cylinder.

The Battery connected with the District Key-board and Alarm Circuits consists of about twenty-five pairs of Grove's arrangement of large size. Very considerable power is required to produce the necessary electro-magnetic effects at the Alarm Stations, even through circuits not exceeding four and a quarter miles in length. A great economy of battery power is therefore obtained by the action of the Key-board, which communicates the same Signal in succession to the different Circuits.

In connection with each of the Alarm Circuits, as they pass out of the Central Office, is an Alarm Bell Register for indicating the number of Electric impulses sent over the wires, and the corresponding number of blows struck upon the bells by the hammers of the Striking Machines. In form it is similar to a register in use for other purposes. The movement resembles that of Mr. Farmer's electro-magnetic clock. There are three cylinders, seen partially in the figure, whose circumference is divided decimally and marked with figures, representing in their place, units, tens, and hundreds. The armature of an electro-magnet carries a ratchet, which at every impulse of the current moves the unit cylinder forward one figure, at every tenth impulse moves the cylinder of tens also forward one figure, and at every hundredth impulse moves the cylinder of hundreds forward one figure, in addition to both the others. The indications of this instrument are very important in connection with machines carried by weight. Thus, if alarms are very frequent, the Alarm Bell Register may show that the striking machines require to be wound up in anticipation of their regular time.

7.

It is essential to have systematic means of testing all the Circuits, employed in the Fire System. Where a closed Signal Circuit is used, an interruption from any cause, gives of itself a Signal at the Central Office. Where an open circuit is used, as it is, in connection with the Alarm machinery, or may be, in connection with the Signal apparatus, other means must be employed. The Testing Clock is shown in fig. 8, (see next page.) It is a common once-striking clock, of which the hammer and bell are removed, and the cylinder *a*, so connected with the striking movement as to make one revolution at the usual time of striking. On this cylinder are pins arranged spirally, equal in number to the number of Circuits which it is desired to test. These pins in the course of their revolution, deflect each a testing key *b*, of which keys, for the sake of clearness, only one, with the corresponding parts is shown in the figure. The upper part of the testing key is made thin and elastic, so as to yield slightly to the passage of the pin. Its arrangement in the figure shows its application to testing the continuity of one of the Signal wires, represented in fig. 2. In its usual position, the testing key is held by a spring, in contact (which should be a sliding contact,) with the little anvil *d*. It will be seen that the wire *k*, connected with the zinc pole of the battery *i*, makes a perfect circle, returning into itself through the screw-cups connected with *d* and the axis of the testing key. When moved by the revolution of the cylinder, the key breaks the contact at *d*, and makes contact with the little anvil *e*, which is connected through the electro-magnet *f*, with the platina pole of the battery. Hence it completes the circuit, if the wire *k* is unbroken, and the bell *h* is struck by the hammer carried by the armature and lever *g*.

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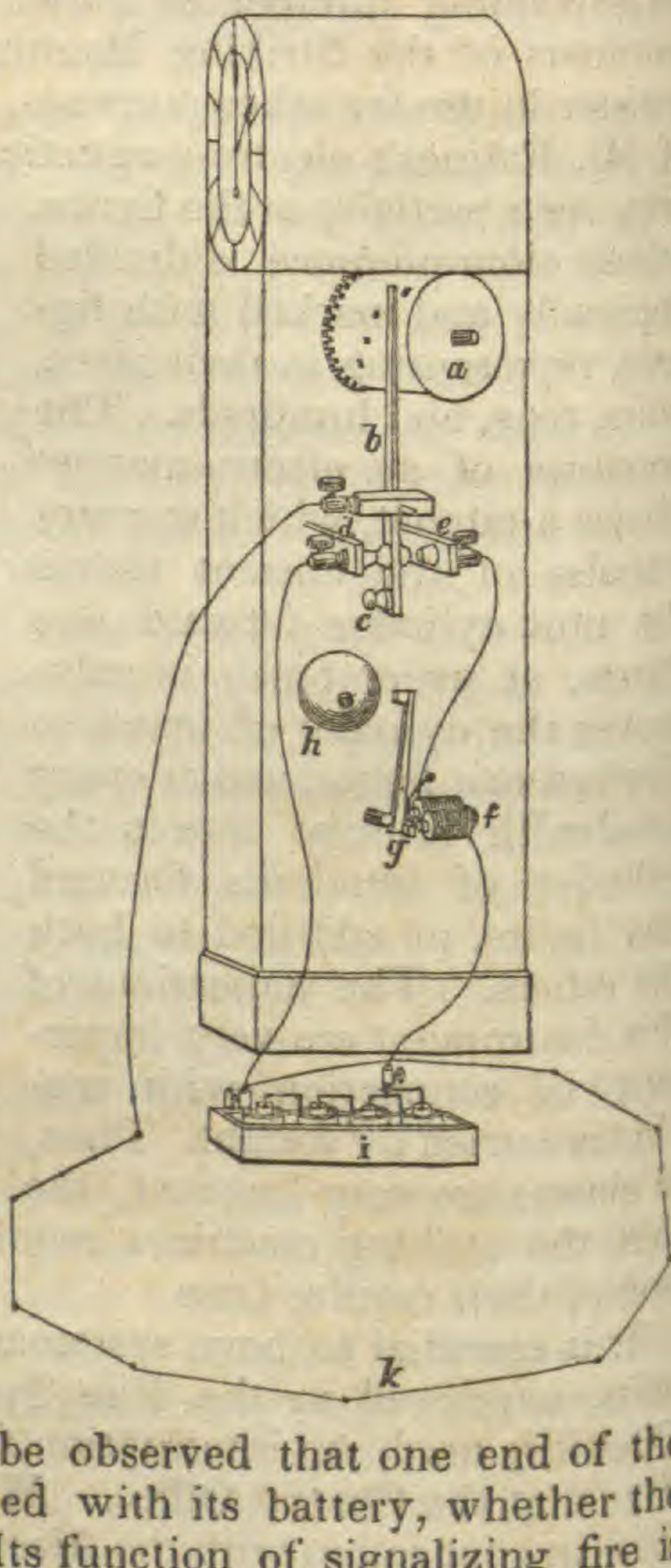


The knob *c*, on the lower part of the testing key, makes it available for use, at any intermediate time, by hand. The arrangement of this key also shows how a single wire of the Signal Battery can be brought into circuit, for the purpose of communicating back to the Stations. It will be observed that one end of the wire *k* always remains connected with its battery, whether the key *b* is manipulated or not. Its function of signalizing fire is therefore never interfered with.

The testing key applied to the Alarm Circuit connects it momentarily with a battery, perhaps the Signal battery, too weak to set off any of the striking machinery, and yet strong enough to actuate the electro-magnetic alarm within the clock. In the Boston System, if the six wires of the Signal Circuits and the three Alarm Circuits should be tested together, nine bells would be struck in regular succession, at the time of the usual striking of the clock. These should be separated from each other in tone by a musical interval, and bells representing different classes of circuits should be in different parts of the scale. If one of these notes were omitted it would at once be perceived. Taken together, the chime would furnish hourly assurance of the integrity of all the Circuits of the System.

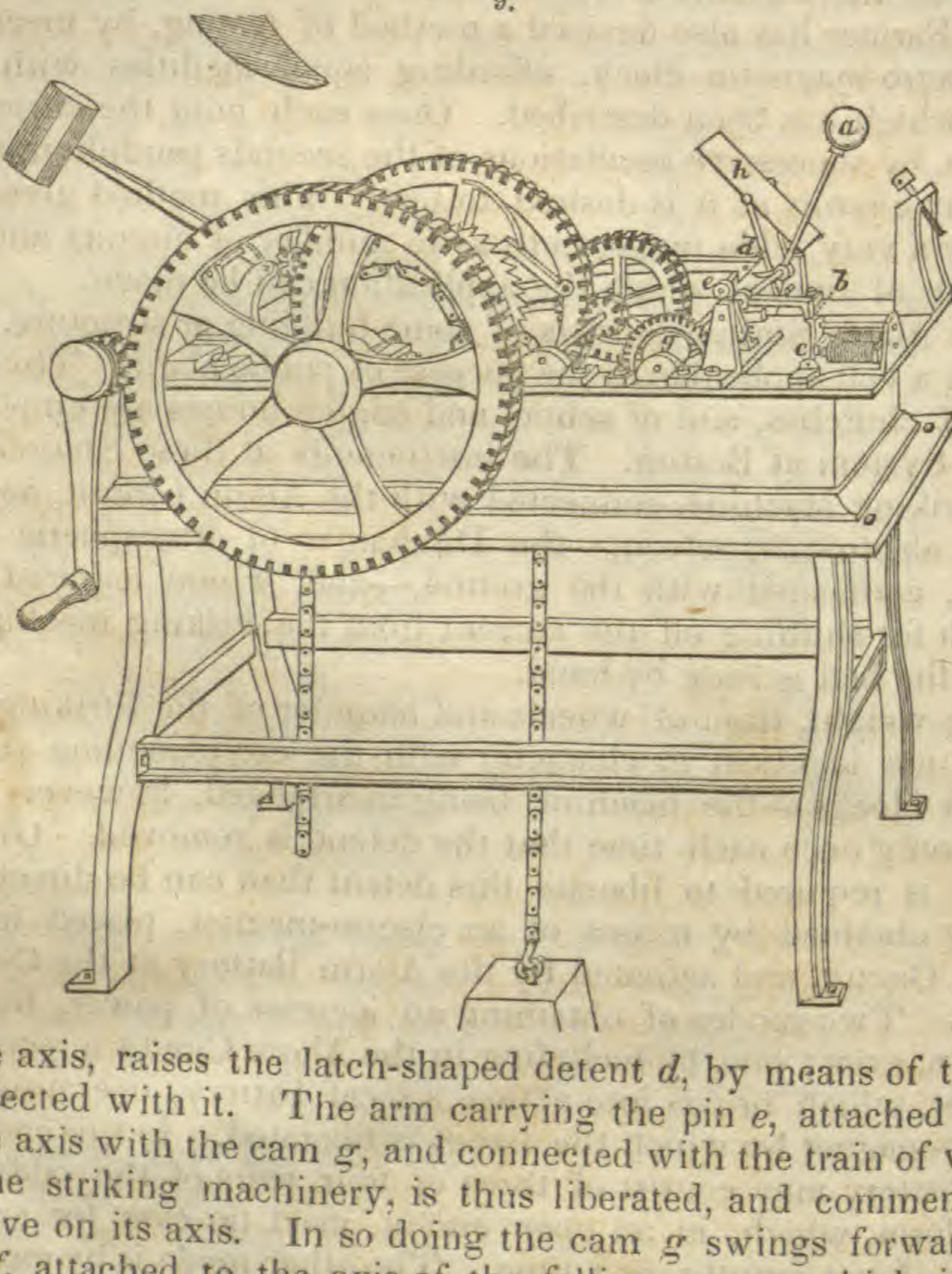
Mr. Farmer has also devised a method of testing, by means of his electro-magnetic clock, affording equal facilities with the mode which has been described. Once each hour the current is thrown, by successive oscillations of the seconds pendulum, upon as many circuits as it is desired to test. This method gives obviously a very wide range, both as to number of circuits and the intervals of time at which the application can be made.

The Alarm Station consists of some building or structure, containing a bell applicable to the purpose of public alarm. Thus the bells of churches, and of school and engine houses are employed in the System at Boston. The instruments at these Stations are the Striking Machine, connected with the Alarm Circuit, and set off by electro-magnetism,—the Discharger of atmospheric electricity, connected with the ground,—and, where required, the Switch for shutting off the current from the striking machinery, when the bell is rung by hand.

The weight, train of wheels and hammer of the Striking Machine, are identical in character with the corresponding part of church clocks,—the machine being so arranged, however, as to strike only once each time that the detent is removed. Greater power is required to liberate this detent than can be directly or readily obtained by means of an electro-magnet, placed in the Alarm Circuit, and actuated by the Alarm Battery at the Central Office. Two modes of obtaining an increase of power, for this purpose, exist; one, by including in the Alarm Circuit a receiving magnet, which brings into action a local battery, operating the electro-magnet by which the detent is liberated. In this case the local battery may consist of three or four pairs of the odds and ends form, which, in an open circuit, need no care for several weeks, if not months, at a time. The other mode is by employing some secondary apparatus, liberated by the electro-magnet in the Alarm Circuit, to raise the detent. This method was applied by Mr. Farmer in 1848, in his very beautiful instrument, which which will now be described.

Fig. 9 (see next page) represents the precise form of the Striking Machines, constructed by Howard & Davis, for the City of Boston. The frame is a most substantial casting. The electro-magnet will readily be recognized, with its armature attached to an upright lever at *c*. The legs of the electro-magnet consist of half-inch soft iron, surrounded with coils of insulated copper wire No. 23, which are three inches long and two inches in diameter. *a* is a falling arm, weighted at the top, which is supported in an upright position by a horizontal lever, resting on the top of the armature lever at *b*. When the armature is attracted to the magnet, the weighted arm *a* falls over until stopped by the adjustable rest in front of it. In falling, a little lever, seen attached to the

9.



same axis, raises the latch-shaped detent *d*, by means of the pin connected with it. The arm carrying the pin *e*, attached to the same axis with the cam *g*, and connected with the train of wheels of the striking machinery, is thus liberated, and commences to revolve on its axis. In so doing the cam *g* swings forward the bar *f*, attached to the axis of the falling arm *a*, which is thus raised to its original position; the horizontal lever catches again at *b* if the armature has been released, the detent *d* falls, and the pin *e* is arrested at the end of one revolution. This occupies two seconds, and in the meantime the weight of perhaps 2000 lbs. has fallen an inch, and a single blow has been struck by the hammer. If the armature were not released from the attraction of the electro-magnet, the horizontal lever would not catch at *b*, and the machine would continue to strike, until the circuit, influencing the electro-magnet, was interrupted. This indefinite and undesirable mode of striking would be produced by holding down the Alarm Key at the Central Office. To obtain single blows, for the purpose of definite alarm, the circuit must be completed momentarily at suitable intervals, which is best effected by means of the District Key-board. The fly-wheel of the clock work is shown at *h*. The hammer represented in the figure is usually placed in a belfry above, connected with the hammer lever by a wire.

The bells to which the striking machines are applied in Boston, vary in weight from 3,700 to 300 lbs. The machines are of uniform size, but they are carried by weights, varying from 2000 to 800 lbs., on a single chain. It was supposed in the outset that a blow equal in force to that of the common tolling hammers, would be sufficient for all the purposes of alarm, especially as, in the Telegraphic System, an alarm is not propagated by sound, from bell to bell, as in the ordinary method. A greater amount of sound was however considered desirable by members of the Fire Department, and a great addition to the force of the hammer was found necessary to produce adequate vibration in the largest bells. Thus the hammer, judged suitable for the bell of Brattle St. Church, weighs forty pounds, has a handle three and a half feet long, swings through an arc of four and a half feet, and is moved at each blow by a force equal to a weight of 1440 lbs., falling one inch. To liberate the detent of a machine of this power, the weight on the falling arm must be proportionally increased, and the electro-magnetic power required to free the arm will amount to about 14,000 grains when the armature (faced with brass) is in contact with the electro-magnet. The battery provided at the Central Office must be adequate to produce this effect through the Alarm Circuits.

The striking machines are calculated to strike 1000 blows with a fall of the weight equal to 83·33 feet on a single chain, that is, at the rate of one inch to a blow. Where a great expenditure of power is required, and the weight is applied by a single chain with a limited fall, the number of blows which can be obtained from a single winding is necessarily diminished. Thus the number of blows with the three largest bells in Boston, will not probably exceed 450 or 500. Fortunately these bells are near the Central Office, and can be easily wound up when the Alarm Bell Register, represented in fig. 7, indicates that they are nearly run down.

The striking machines should be wound weekly, and a detailed report made, by the person winding them, to the Central Office, where it should be entered on the journal. All intermediate windings should be entered in a similar manner.

The time required between successive blows of the Striking Machines is two seconds. The revolution of the cylinder in the District Key-board, fig. 6, should be graduated so as to complete the circuit, for consecutive blows, at precisely this interval. The average number of blows, in striking District Signals with intervals of five seconds after each Signal, is about twenty per minute. From fifty to a hundred blows would be sufficient, ordinarily, for a single alarm.

A single Alarm Circuit may include a number of Alarm Stations. In all of these, in which the conditions are similar, the blows upon the bell should be synchronous. No matter how widely scattered over a City, the Signals would be struck on the different bells practically at the same moment of time. Differences however in size, friction, proportion, would always exist, sufficient to make a slight difference in the instant of striking between a number of bells. Even if this were not so, difference in distance would cause the sound of one bell to reach the ear before another. Hence District Signals are always distinguished by listening to the sound of a single bell. The effect of the District Key-board is to strike in succession the bells of different Circuits. The interval in sound, however, thus occasioned, would not be so great as that produced by distance in bells of the same Circuit.

In Boston there are eight Telegraphic Alarm Bells in the North Circuit, nine in the South Circuit and two in the South Boston Circuit. These bells are for the most part the same previously employed for the purpose of alarm. The irregularity of surface in the City indicated the use of a number of bells, instead of the employment of a few large ones as in New York. The resistance to the battery current in the South Circuit, $3\frac{1}{2}$ miles in length and including nine Alarm Stations, is greater than in either of the others. The coils on the electro-magnet of each striking machine offer a resistance equal to a mile of single No. 8 wire, or to half a mile of double wire. The nine Stations would be equal therefore in resistance to $4\frac{1}{2}$ miles of Circuit, which gives a total resistance of eight miles of double No. 8 wire, through which the Battery must act.

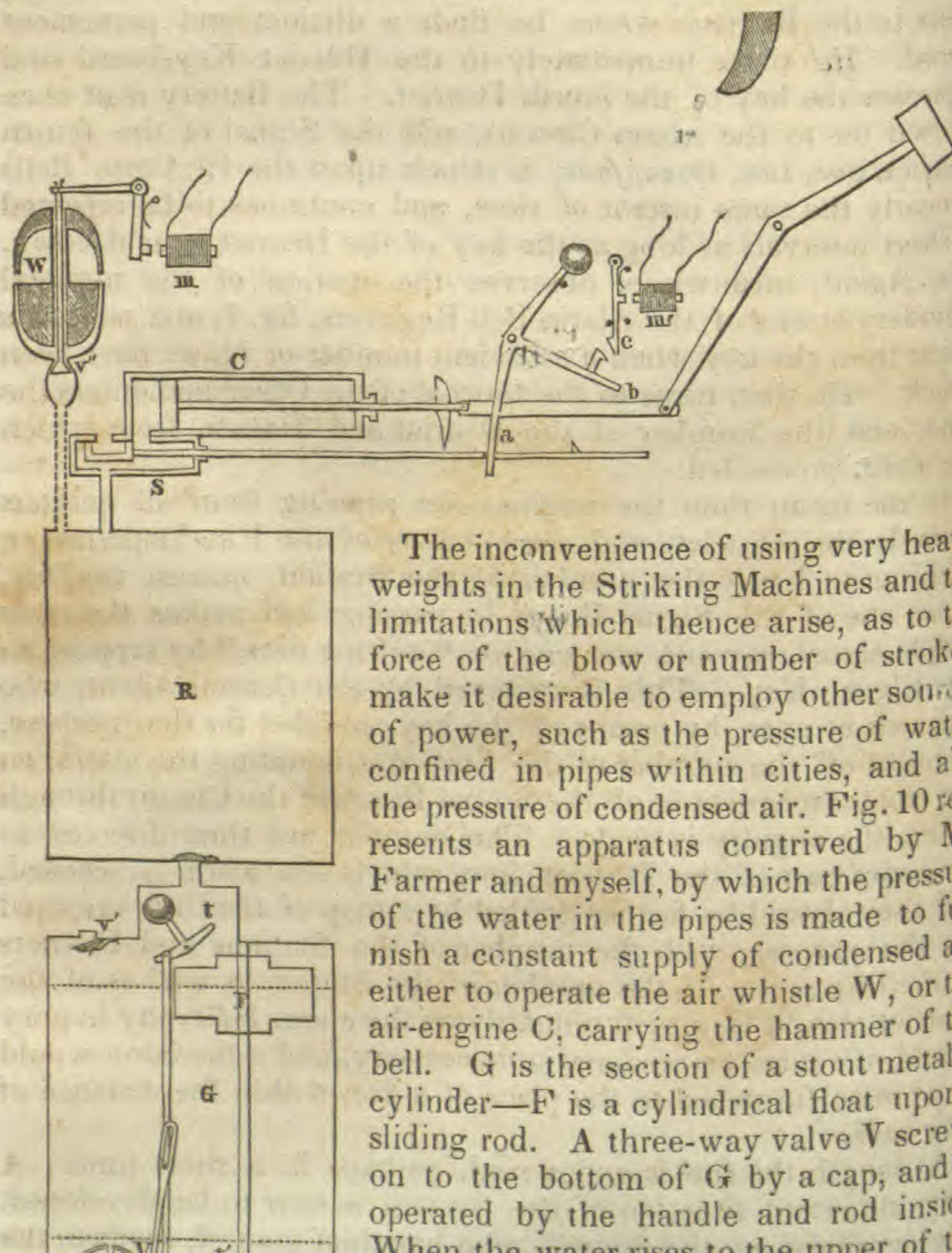
The Dischargers of atmospheric electricity at the Alarm Stations are similar in principle to those already described, and need not be farther considered. Where the bells are rung for other purposes, it is necessary that there shonld be a lever within reach of the bell ringer, communicating with a Switch above, for the purpose of turning the current off from the coils of the Striking Machine through a short circuit, during the period of ringing the bell. Otherwise the bell or hammer would be liable to injury in case the actions of ringing and striking should proceed at the same time. A little electro-magnetic alarm may also be provided to notify the bell ringer of the commencement of an alarm of fire, to which it would be his duty to give precedence. A Switch, which should be automatic, or dependent simply on the commencement and cessation of the motions of ringing, would on many accounts be desirable.

The operation of the System has been shown in its detached parts. It will now be illustrated consecutively through all its stages. A fire having broken out in the neighborhood of the fifth Signal Station in the Fourth District, of which the Box is represented in fig. 4, the person in charge of this Station, or, at night, a watchman, opens the Signal Box and turns the Crank six times. The Alarm at the Central Office is struck every time that the circuit is closed, and the Register records, at the same moment, the District Signal of four consecutive marks, six times repeated, alternating with the Telegraphic Signal, a dot, a line and a dot, indicating the number of the fifth Station. The Agent at the Central Office, if aroused at night by the Alarm, refers to the Register where he finds a distinct and permanent record. He turns immediately to the District Key-board and depresses the key of the fourth District. The Battery is at once thrown on to the Alarm Circuits, and the Signal of the fourth District, *one*, *two*, *three*, *four*, is struck upon the 19 Alarm Bells at nearly the same instant of time, and continues to be repeated at short intervals as long as the key of the District is held down. The Agent, meanwhile, observes the motion of the numeral cylinders in one of the Alarm Bell Registers, fig. 7, and raises his finger from the key when a sufficient number of blows have been struck. He then turns to the Journal of the Office and enters the time, and the number of the District and Station, from which the alarm proceeded.

In the mean time the engines are running from all quarters towards the District, and some officer of the Fire Department, wishing to know the number of the Station, nearest the fire, opens one of the Signal Boxes in passing, and makes the most simple signal, say *one*, *one*, *one*, or "writing dots," by tapping on the Signal Key. This is received by the Central Agent, who proceeds at once, by means of the key provided for that purpose, to count off the number of the Station originating the alarm, on the electro-magnets in all the Signal Boxes of the Circuit through which the enquiry is made. The engines are thus directed to the exact part of the District from which the alarm proceeded, and they should be farther guided by a map of the City, prepared for the purpose, with the number of the Stations and Districts marked upon it. If the number of the Station as well as of the District should be struck primarily on the alarm bells, any inquiry would of course be rendered unnecesssary, and a direction would be at once furnished to the place of a fire, within the distance of fifty rods.

At length the fire is suppressed, perhaps in a short time. A very important function of the System is now to be developed. The engineer, on the ground, who has chief control, sends to the nearest Signal Box and communicates the Signal *one*, *one-two*,—*one*, *one-two*, which signifies "All Out." This is received by the Agent at the Central Office, who immediately depresses the key of the District Key-board, marked in fig. 6 with the characters I, II. This Signal is forthwith struck and repeated a few times on all the bells. The engines in various and perhaps distant parts of the city turn back. A different signal might be employed to order back the South Boston or North End engines, and two spare keys, having connection with only a single circuit, may be added to the Key-board for this purpose; or the Agent may send such a signal over any Alarm Circuit by means of the Alarm Key.

10.



The inconvenience of using very heavy weights in the Striking Machines and the limitations which thence arise, as to the force of the blow or number of strokes, make it desirable to employ other sources of power, such as the pressure of water, confined in pipes within cities, and also the pressure of condensed air. Fig. 10 represents an apparatus contrived by Mr. Farmer and myself, by which the pressure of the water in the pipes is made to furnish a constant supply of condensed air, either to operate the air whistle W, or the air-engine C, carrying the hammer of the bell. G is the section of a stout metallic cylinder—F is a cylindrical float upon a sliding rod. A three-way valve V screws on to the bottom of G by a cap, and is operated by the handle and rod inside. When the water rises to the upper of the two dotted lines, the top of the float raises the tail-piece t of a small lever, carrying an upright arm, with a heavy ball on the top. This ball passes beyond the perpendicular and falls over on the other side, as seen in the figure, reversing at the same moment the three-way valve by a simple arrangement. The water which before entered now begins to flow out. The valve v′ opens and admits air. The float falls until at last it rests on the tail piece t′ of a corresponding short lever below, by which the heavy ball is raised to the perpendicular and thrown over on the other side, reversing the three-way valve again, so that the water enters. The water, on entering each time, condenses the air into the reservoir R, from which a valve prevents any return. This process continues till the air in R has reached a condensation equal to the pressure of the column of water in the pipes. Any loss of pressure from either leakage or use is at once supplied by the action of the generator G. All the parts in the generator liable to oxydation, are made of brass.

The reservoir R may easily contain several hundred charges for the cylinder C, so that if the water should be withdrawn from the pipes for a day or more, no interruption in the means of alarm would take place. With a pressure of two or three atmospheres, such as can be obtained from the Cochituate water in the lower part of Boston, a cylinder, C, of only two or three inches diameter, applied directly to a hammer as above, would give all the power which could be desired for the largest bell, without any limit as to the number of strokes, or necessity of winding. The electro-magnet m′, armature and catch c, on which the corresponding part of the falling arm rests, when raised from the position in the figure, will be easily recognized. When the armature is attracted to the magnet the falling arm drops, and the foot, a, strikes a pin on the sliding valve and throws it back, admitting the air into the cylinder. The cam and projection on the end of the piston rod, respectively reverse the sliding valve, and raise the long arm b of the falling lever, at the end of the stroke. In the apparatus represented, the generator G must, of course, be placed in a low situation, such as a cellar, and out of the reach of frost.

The air whistle, operated by hand, was proposed a year ago in Boston as a means of alarm. Its efficiency for this purpose can hardly be overrated. The simple mode of connecting it with the Telegraph, represented in the figure, has been proposed by Mr. Farmer. The air valve v″ is operated by a rod, attached to the armature lever of the electro-magnet m, which is actuated by a local battery connected with the Telegraphic circuit. The same object may be accomplished, without a local battery, by a little falling lever and air engine apparatus. Two or three air whistles of large size in a City, would be almost sufficient of themselves for a System of Alarm.

The use of the water meter of Mr. Huse, as a source of power for striking the bells, has suggested itself, and has also been especially brought to my notice by Mr. Joseph M. Wightman of Boston.

This very useful and ingenious instrument can be best described as the converse of a rotary pump. I have satisfied myself that the falling arm liberated by the electro-magnet, could be made to open the water-valve, and that a meter supplied by an inch or inch and a half pipe, would furnish ample power to lift the hammer required for any of the City bells. For this purpose an arm may be placed across the axis of a meter, each end of which, in revolving, would raise the lever connected with the hammer handle above. The hammer would thus be raised at every half revolution of the meter. As the pressure of the water is liable to vary, or as it may be completely withdrawn, an intermediate reservoir of water under the pressure of air, condensed by the previous entrance of water from the pipes, the return of which is prevented by a valve, would seem to be necessary. This is the chief objection to its use. Greater electro-magnetic power would be required to work a water-valve, than the air-valve represented in the last figure.

The principal instruments employed in the Fire Alarm System are included under no existing patent, although Mr. Farmer reserves to himself the right to those parts of the mechanism which he has originated. The electro-magnetic Register, patented by Professor Morse, constitutes, however, an exception. It is desirable to use this instrument for the record at the Central Office, as its principle is in harmony with the rest of the System. On this account, and also to set at rest any other claim under the patent of the electro-magnetic Telegraph, I should recommend, in all cases of construction the purchase of the right to the use of the Morse instruments in connection with the System. This has accordingly been done by the City of Boston.

The following table furnishes an approximation to the cost of different parts of the System, erected in Boston, which is of interest in connection with future constructions.

Average cost per mile of 49 miles wire, (erected) .	$68 72
" " of wire No. 8, per mile, . . .	73 00
" " " " No. 10, " "	62 50
Striking machine, fig. 9, (including 800 lbs. weight,)	165 00
Signal Box, apparatus and connections, complete, .	10 00
District Key-board, fig. 6, (with 12 keys), . .	75 00
Alarm Bell Register, fig. 7, ...	10 00
Office Alarm, fig. 5, ...	8 00

The estimate, furnished by me to the City Government of Boston, of the cost of construction of the System, was about $8000, not including superintendence or the right to the use of the Morse instruments. It is believed that this estimate has not been exceeded by the actual cost of the parts included in it. An addition has been made to the number of Signal Stations and to the length of the Signal wires, and also to the proposed power of the Striking Machines, by which the total expense will be increased perhaps more than a thousand dollars. The cost of superintendence and of the patent right will probably amount to nearly two thousand dollars.

The System can be introduced into small towns where two or three bells and a few Signal Stations are to be connected with the wires, at a cost, for the mechanical part, not exceeding one thousand or fifteen hundred dollars,—and into larger towns or cities at a proportionate rate. In the smaller towns the same wires may be used for both Circuits, that is, to constitute a closed Signal Circuit with a feeble battery, and subsequently an Alarm Circuit, by switching on, at the Central Office, a powerful Alarm Battery. This would diminish the cost of the Circuits nearly one half, but the principle of double conductors, in this case, should still be preserved.

In the approach of the System to its completion in Boston, no doubt exists as to its mechanical efficiency, and to the precision of its operation, except where departures, almost unavoidable in a first experience, may have been made from the principles of construction, already indicated. The introduction of the System may be influenced by moral causes, but these have not been found, heretofore, to embarrass the working of the Telegraph in this country. Here is simply a test of the civilization of our people. Local and peculiar obstacles may also affect the System in its introduction. It is believed that none of these difficulties will prove insurmountable in the trial about to be made in Boston, but that with patience and experience the uses of the System will be fully developed. Should it be otherwise, the System is still correct in principle, and will wait its own time for general adoption.

Great credit is due to the government of the City of Boston for the liberality with which it has tried this experiment. To the Superintendent, Mr. Farmer, intelligently seconded by the Committee of construction, the praise of great practical efficiency and skill should also be awarded.

The application of the Telegraph to Fire Alarms is a step in Municipal organization which has become necessary and must lead to others of a higher order. The beautiful chronometric application of the Telegraph, by which a single clock registers its time on an indefinite number of dials throughout a city, by the simple magic of the electric circuit, is also one which deserves to be brought into immediate public use.

Boston, Nov. 11, 1851.

ART. X.—*Observations on the Freezing of Vegetables, and on the Causes which enable some Plants to endure the action of extreme Cold;* by JOHN LE CONTE, M.D., Professor of Natural Philosophy and Chemistry in the University of Georgia.*

IN the years 1775 and 1777, John Hunter communicated to the Royal Society two series of experiments on the "Heat of Animals and Vegetables," from which he drew the inference, "that an animal must be deprived of life before it can be frozen," and "that plants when in a state of actual vegetation, or even in such a state as to be capable of vegetating under certain circumstances, *must be deprived of their principle of vegetation before they can be frozen.*"† Again he says, "But the question is, is every tree dead that is frozen? I can only say, that in all the experiments I ever made upon trees and shrubs, whether in the growing or active state, or in the passive, that whole or part which was frozen, was dead when thawed."‡

With respect to animals, Hunter concluded from his experiments, that when the whole was frozen the actions of life could *never* be restored; but that the ears of rabbits and the combs of cocks were frozen without injury to the parts.§ More recent observations have convinced animal physiologists that Hunter's generalization was premature; and that a degree of cold which absolutely freezes their bodies is not equally fatal to all classes of animals. The warm-blooded vertebrata are destroyed by it; and many insects in their perfect state are said to suffer in like manner. On the other hand, many fishes, and some reptiles, may be completely frozen without their vitality being necessarily lost. Sir John Franklin, Pallas, Bell, and many others relate, that certain species of fish, which are found imbedded in the ice of the polar regions, are restored to life when thawed. Hearne in his journey from Hudson's Bay to the Northern Ocean, mentions his having found various species of frogs so completely frozen that their legs were as brittle as pipe-stems, and which resumed their natural movements when exposed to a genial heat. If permitted to freeze again after being thawed, they never recovered. He found spiders and grubs in a like frozen condition, with the same powers of revivification on exposure to a warm atmosphere.‖ The *larvæ* of insects are equally tenacious of vitality. Lister, Bonnet and others, have found caterpillars so frozen that when drop-

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* Read before the "Physical Section" of the "American Association for the Advancement of Science" at the Albany meeting, August 19th, 1851.

† Phil. Trans. for 1775, pp. 452 and 454. ‡ Phil. Trans. for 1778, p. 40.

§ Phil. Trans. for 1778, p. 34, et seq.

‖ Vide Hearne's Journey from Prince Wales' Fort, Hudson's Bay to the Northern Ocean, pp. 397 et 398. Lond., 1795.

ped into a glass they chinked like stones; but that they nevertheless revived. The Papilio brassicæ has been produced from a larva which had been exposed to a cold of 0° Fahr., and which had become a lump of ice. Spallanzani found that exposure to a temperature of –38° or even –56° Fahr., did not destroy the fertility of the ova of silk worms; and the eggs of the slug have been subjected to a cold of –40° Fahr. without injury. The following experiment upon caterpillars, tried in Sir John Ross's voyage, seems to be perfectly satisfactory on this point. Thirty larvæ of the Laria Rossii were put in a box, and exposed to the winter temperature for three months; on bringing them into the cabin, every one of them returned to life and crawled about. They were again exposed to an atmosphere of –40° Fahr., and instantly became re-frozen; after a week, they were brought again into the cabin, and twenty-three returned to life. These were again exposed and re-frozen; and, after being solid for another week, *eleven* of them recovered on being brought into the cabin. A fourth time they were frozen, and only *two* survived.*

The foregoing facts appear to indicate, that the power of revivification after the complete congelation of the fluids, is confined to animals in which the function of calorification is imperfectly performed, and in which all the vital processes are obscurely manifested. As all the functions of vitality are still more obscurely performed in plants, we should naturally expect them to be endowed with a similar power of resisting the destructive effects of freezing. Nevertheless, the most eminent writers on vegetable physiology seem to be very general and decided in the opinion, that the complete solidification of the fluids of a plant necessarily and inevitably results in its death. For, although it is well known to practical horticulturists, that the pernicious consequences of severe cold on growing vegetables, may be, to some extent, obviated by careful and gradual thawing; yet, it is thought

* Vide Carpenter's Principles of General and Comparative Physiology. 2nd ed. Lond., 1841. pp. 158, 174 and 175.

The recent observations of Prof. James Paget, seem to show, contrary to the opinion of Hunter, that it is *not* by the power of a vital principle that eggs resist the influence of cold. His experiments prove, "that certain things will destroy the power of resisting cold without affecting the capability of being developed, and of therein manifesting the best evidence of life; and that when eggs yield to the influence of intense cold, they are not damaged unless they are frozen, and are *not killed* even when frozen. The experiments thus remove almost the only remaining support of the hypothesis that such a vital principle *may exist in organized* bodies, as may enable them, even while inactive and displaying no other signs of life, to resist passively the influence of physical forces." Prof. Paget thinks, that the fact that the temperature of eggs may be reduced far below the freezing point without being frozen, is due, not to any vital principle, but to some peculiarity of the mechanical constitution of the albumen, "by means of which the water combined with it is held so steadily, that the agitation favorable, or even necessary, to the freezing at or near 32° cannot take place," (vide Phil. Trans. for 1850, p. 221, et seq.)

that, in such cases, the freezing is incomplete and does not involve all of the structures of the plant. Thus for example, M. Aug. Pyr. De Candolle, after enumerating the effects produced by a partial freezing of the internal parts of trees, in which the *alburnum* is the only part attacked and disorganized, giving rise to what are called *gelivures*—remarks, "Enfin, si le gel est assez fort dont le liber, *alors la branche ou l'arbre dont le liber gèle pèrit presque toujours*, soit que la gelée du liber soit un signe de la gelée totale de l'aubier, soit que le rôle du liber soit luimême plus important et lié avec la congélation de tous les bourgeons."*

Again he says, "Si elle (la temperature) descend au-dessous de la congélation, elle solidifié d'abord l'eau située à l'exterieur du végétal, et arrète d'autant la nutrition; puis elle atteint les liquides aqueux renfermés dans le tissu végétal, en les congelant elle les dilate; de cette dilatation résulte *la mort du végétal ou du fragment de la plante où elle a lieu*, soit, comme l'ont cru plusieurs auteurs, par la rupture des cellules et des vaisseaux (fait que les recherches récentes de M. Gœppert rendent au moins très douteux), soit par la dénaturation des sucs euxmêmes que la gelée tend à séparer en parties plus ou moins susceptibles de congelation, soit simplement par un effet vital sur le tissu des cellules."† Prof. J. S. Henslow remarks that, "when the sap is frozen, the cells and vessels in which it is contained are ruptured, *and the parts subjected to such an accident die.*"‡ Again, the same botanist says, that, "whenever the sap does freeze, it produces the effect technically termed "shakes" (probably the *roulure* of the French) in timber trees, which consists in a tendency in the separate layers of wood to disunite."§ References might be multiplied to show how universal this opinion is among the best vegetable physiologists. Although most of them reject the idea of Hunter, that a plant must be deprived of the principle of vegetation *before* it can be frozen; yet they appear to be almost unanimous in the opinion, that *after* complete congelation it necessarily dies. It is true, that several facts which seem to contravene this opinion have not failed to arrest the attention of several botanists. Thus M. De Candolle cites the fact, attested by M. Thouin, that the cases of apple trees sent to Moscow, arrived there in a frozen condition, and that a great part of them were saved by gradual and slow thawing.|| It appears however that such phenomena have attracted but little attention, and provoked no scientific research; they have remained barren and isolated facts in the field of science.

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* Physiologie Végétale, tome 3, p. 1119. Paris, 1832.
† Op. cit., supra tome 3, p. 1101.
‡ Principles of Descriptive and Physiological Botany, Lardner's Cabinet Cyclopedia, p. 297. London, 1844.
§ Op. cit. supra, p. 173.
|| Physiologie Végétale, tome 3, p. 1122.

From a careful examination of Hunter's experiments, I am surprised, that either he or his successors should have drawn such conclusions as have been deduced from them in relation to the effects of cold on vegetables. For example, we will cite his second experiment in his earlier paper; "A young Scotch fir, which had two complete shoots and a third growing, and which consequently was in its third year, was put into the cold mixture which was between 15° and 17° Fahr. The last shoot was frozen with great difficulty, which appeared to be owing in some measure to the repulsion between the plants and the water. When thawed, the young shoot was found flaccid. *It was planted;* the first and second we found *retained life*, while the third or growing shoot withered."*

Again, in his second series of experiments, when the temperature of the air was 16° Fahr., he found a thermometer inserted into the trunks of a number of species of trees, to stand at 17° Fahr. Now, he found that the sap taken from the walnut tree on which he made the experiment, would freeze at 32°; and furthermore, that the sap which filled an old hole which he had made in the same tree, became frozen when the temperature of it was 31° Fahr.

Assuming that the juices of the tree were not frozen when their temperature was 17° Fahr., Hunter very naturally inquires, "Now, since the sap of a tree when taken out freezes at 32° Fahr.; also since the sap of the tree when taken out of its proper canals, freezes when the heat of the tree is at 31°; and since the heat of the tree can be as low as 17° Fahr. without freezing; by what power are the juices of the tree, when in their proper canals, kept fluid in such cold? Is it the principle of vegetation?"† Hunter has not informed us in what manner he ascertained that the juices of the tree were not frozen when their temperature was 17° Fahr.; but the presumption is, that he had no other reason for thinking so, than the fact, that the tree *was not killed.* He appears to have been so much prepossessed with the idea that plants "must be deprived of their principle of vegetation before they *can* be frozen," that he never thought of determining, by direct observation, whether or not the sap of the tree was actually frozen when its temperature was 17° Fahr. The very first principles of philosophizing demand, that it should be clearly and undeniably established as *a matter of fact*, that *every case* in which the sap of a plant *is frozen* is invariably followed by the death of the whole plant or at least of the part congealed, before the fact of its having survived, can be made the basis of the conclusion that congelation of the juices had not taken place. The assumption is made that a plant which is not killed by cold,

* Phil. Trans. for 1775, p. 451.

† Phil. Trans. for 1778, pp. 47, 48.

never was frozen, and then theories are framed to account for the presumed fact.

Impressed with this fundamental idea, all attempts which have been made by modern phytologists to explain how vegetables endure the action of excessive cold, resolve themselves into an enumeration of the possible causes which may prevent their juices from freezing. M. Aug. Pyr. De Candolle has investigated the action of these causes with his characteristic capacity.*

The causes to which this assumed resistance to freezing has been ascribed, may be reduced to *five*;—1. A certain amount of *proper heat* generated by physiological actions; 2. The viscosity of the juices lowering the freezing point; 3. The distribution of the sap through minute vesicles and capillary vessels depressing the point of congelation still further; 4. The warmth of the ground from which the sap is pumped up; 5. The low conducting power of concentric layers of bark with entangled air included in their meshes, and of the wood itself, which is less transversely than longitudinally. We shall examine the adequacy of each of these causes to account for the facts.

1. The experiments of J. Hunter, Schœpff, Bierkander, Pictet and Maurice, Schubler and Neuffer Hermstädt, Nau. Gœppert and others, have shown, that the interior of the trunks of large trees possesses, during winter, a temperature several degrees higher than that of the surrounding air. But, M. De Candolle and others have very reasonably doubted whether known physical causes might not be sufficient to account for the fact, without the necessity of ascribing it to the result of any physiological action. By recent experiments, however, made with instruments of great susceptibility to changes of temperature—such as the thermo-multiplier of Nobili—MM. Dutrochet, Becquerel and Breschet, have demonstrated, that in those parts of plants in which the vital processes are taking place with activity, an appreciable amount of caloric is constantly evolved. The amount of this evolution of heat is generally *very low*,—not more, in fact, than a *single degree* Fahr. in the herbaceous parts of actively-growing plants; and as it does not more than counterbalance the effect of evaporation, which is continually taking place from the surface, there is, under ordinary circumstances,—so far as *this cause* is concerned,—no sensible difference between the temperature of the plant and that of the surrounding atmosphere.† During the winter, when these functions are comparatively dormant, we cannot suppose that they operate at all in resisting any atmospheric changes which might be injurious to vegetation. Nevertheless, as vital changes are taking place with more or less activity at all periods,

* Physiologie Végétale, tome 3, p. 1101, et seq.

† Vide Ann. des Sci., N. S., tome 12. Also Carpenter's General and Comparative Physiology. 2nd ed. Lond., 1841. p. 417.

this may be regarded as a *vera causa*, but its effect, so far as the prevention of freezing is concerned, must be considered absolutely *infinitesimal.*

2. That the freezing point of the juices of plants is but *slightly* depressed below that of water, by the admixture of gum, mucilage, and other products of vegetation which impart viscidity to them, has been demonstrated by direct experiment. Hunter found the freezing point of vegetable juices when squeezed out of a green plant, to vary from 29° to 32° Fahr. In several experiments on the freshly expressed juice of the strawberry, I found the freezing point to vary from 28° to 30° Fahr.; and, in every case, the temperature *after congelation* was 30° Fahr. It is extremely probable, nay, almost certain, that the freezing point may vary with the degree of inspissation of the sap, and may, consequently, be different for different plants, and at different seasons of the year in the same plant; and, moreover, that it may, on this account, be somewhat lower in winter than in spring or summer. It is also probable, that the admixture of certain peculiar organic products may lower the freezing point of the sap of particular plants. Thus it is well known to chemists, that the point of congelation of good oil of turpentine is as low as 14° Fahr.; and, perhaps, the presence of this proximate principle, may tend to prevent the sap of the Coniferæ from freezing in moderate degrees of cold. In the present state of our knowledge, it is impossible for us to assign a definite *quantitative* value to the influence of *viscosity* in lowering the freezing point of the juices of vegetables; but it is certain that it cannot amount to *many* degrees of temperature.* It must have *some* influence, and must, therefore, be looked upon as a *vera causa* acting in the right direction; but in case of *extreme cold*, this cause is obviously *inadequate* to prevent the supervention of congelation.

3. Prof. Henslow seems to think that, "the chief protection against the sap freezing in the trunks of trees, is the circumstance of its being contained in extremely minute vesicles and capillary vessels; for it has been shown that water will resist a temperature of 16¼° Fahr. under similar circumstances; and all viscid fluids are still more difficult to freeze than water."† It is unquestionably true, that by taking certain precautions, water may be cooled 15 or even 20 degrees of Fahrenheit's scale below the proper freezing point, without the supervention of solidification. The

* The fact that the *specific gravity* of the sap of plants is but slightly above that of water, affords presumptive evidence, that the freezing point can be but little below 32° Fahr.; for experiments on the admixture of salts with water show, that the depression of the freezing point is nearly proportional to the increase of *density*. Knight found that the sap of the Acer plantanoïdes in the spring, collected close to the ground, had a specific gravity of 1·004; at seven feet above the ground it became 1·008, and at twelve feet 1·012. (Vide Phil. Trans. for 1805, pp. 90 et 91.)

† Op. cit. ante, p. 173.

essential condition of success in the experiment, is, that it must be cooled without the *slightest agitation*, and no angular body be in contact with it; for the instant any solid body is dropped into water cooled below its freezing point, or a *tremor* is communicated to it, congelation commences and the temperature starts up to 32° Fahr.* It is very obvious, that this *necessary condition* is most effectually secured, by placing the water in *capillary tubes;* for the adhesion of the fluid to the sides of the tubes, must tend to maintain it in that state of absolute repose upon which the success of the experiment depends. Thus Dr. Thomas Thompson succeeded in cooling water in thermometer tubes to 8° and once to 5° Fahr. before it began to freeze.† In the case of trees and shrubs, we have no means of ascertaining how far the *indispensable condition of absolute repose* may be subverted by the perpetual agitation to which their branches and more flexible parts are subjected, through the action of winds. But it seems to me, that in the case of plants, the distribution of the fluids through capillary vessels, can have but slight, if any, influence in the prevention of their congelation.

4. We have already alluded to the fact,—established by the experiments and observations of many distinguished physiologists,—that the interior of the trunks of large trees possesses, during winter, a temperature considerably above that of the surrounding atmosphere. It has, likewise, been shown, that this heat *is not* produced by the physiological actions which are taking place in the plant;—the amount generated by this cause being wholly inappreciable. M. Aug. Pyr. De Candolle very justly ascribes this uniformity of temperature of the interior of trees, to the circumstance of their roots penetrating the earth to a depth where the soil is always warmer than the atmosphere in winter and cooler in summer, and imbibing moisture which must necessarily partake of this influence. Hence it has been observed, that the internal parts of large trees, retain a temperature which is about equal to that of the soil at the mean depth to which their roots penetrate.‡ There can be no doubt that this is the chief cause of the uniformity of temperature of the interior of the *trunks of large trees;* but when considered as a resource against the effects of extreme cold, it is necessary to suppose that its protective action extends to the remotest branch and most minute twig. Now, it will hardly be contended by any one, that a small branch of a tree situated 80 or 100 feet from the ground will have its temperature appreciably modified by the tardy circulation of sap which takes place during the winter. In fact, direct observations

* Graham's Elements of Chemistry. Am. ed. Philad., 1843. pp. 50 et 51.
† Vide Heat and Electricity. London, 1830. p. 175.
‡ Physiologie Végétale. Tome ii, p. 879, et seq. Also, tome iii, pp. 1101, 1102, 1108.

show, that the temperature of the interior of small trees, shrubs and twigs, is sensibly the same as that of the surrounding atmosphere; and the difference becomes more apparent the larger the trunk on which the observation is made, and the nearer it is to the ground. It is manifest, therefore, that,—so far as the buds and smaller branches are concerned,—the cause under consideration, can have no *practical* influence in enabling vegetables to resist the action of excessive cold: its effect must be *infinitesimal.* Moreover, it will be shown hereafter, that perennial plants, and even large forest trees, endure the intense cold of a Siberian winter, *when their roots are imbedded in a soil which is frozen more than one-half of the year.*

5. After what has been said above, it is unnecessary to dwell on the influence of the bad conducting power of the concentric layers of bark, or on the greater facility with which the wood itself transmits heat longitudinally than transversely, as proved by the experiments of MM. Aug. de La Rive and Alph. De Candolle.* These circumstances only prevent the supply of caloric which is pumped up by the roots from the warm earth, from being carried off; but as we have shown, that no appreciable amount of this heat can possibly reach the extreme twigs and buds, it is sufficiently evident, that the low conducting power of the woody layers and bark can have *no sensible* influence in resisting any atmospheric changes which might be injurious to these portions of plants.†

It is proper to remark, that until quite recently, I participated in the opinion so generally prevalent among the most eminent physiologists, that the sap of trees and shrubs which are uninjured by extreme cold, is *never* frozen. I, therefore, entered upon the investigation with all my prepossessions in favor of the commonly received opinion in relation to this subject. Nevertheless, the *glaring inadequacy* of all the causes which have been assigned, to explain the presumed fact, induced me, during the winter of 1850–51, to institute a series of observations and experiments, with the view of obtaining clearer ideas. The sequel will show, that I was very soon driven to the conclusion, that the *fundamental idea* is erroneous, and that plants *do become frozen* without the slightest injury to them.

On the morning of the 18th of November, 1850, I found the leaves of the common garden cabbage covered with hoar frost on both surfaces, and so completely frozen as to be quite rigid and stiff. On more minute examination, it was found, that the

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* Mém. Soc. de Phys. de Genève, vol. iv, p. 71; also, Ann. de Phys., xl, p. 91.

† These considerations seem to show, that those phytologists who are disposed to look at this subject in a teleological point of view, have mistaken the true office of the *scales* which envelop the buds of plants. They can afford no protection against the action of cold.

fluid contained in the petioles as well as that of the mid-ribs and lateral veins was completely frozen. By making a transverse or longitudinal section of them, the *icicles* could be scraped out with the edge of a knife. No indications of congelation could be detected in the parenchyma and smaller veinlets. At the time these observations were made, I had no thermometer with me;—but the weather was quite moderate;—the temperature at sunrise, could not have been below 28° Fahr. The cabbages were uninjured, although most of them were exposed to the direct action of the sun. Subsequently, the leaves of the Gardenia Florida were, on several occasions, observed to be frozen during the frosty mornings in December. They were curled backwards, and were so rigid as to break when an attempt was made to bend them. The foliage was not injured by this degree of cold, although it is by no means a hardy plant.

Doubtless, such facts are familiar to every practical horticulturist; nevertheless, I was anxious to ascertain whether the freezing ever involved the woody structures, and, if so, what was the effect on the plant. As the winter advanced, other opportunities presented themselves for extending these observations. On the morning of the 30th of January, 1851,—the temperature being 18° Fahr. —I examined the larger stems of a number of roses in my garden, and found the fluids of the bark and liber of all of them *completely frozen;—presenting a polished vitreous surface when cut by a sharp knife.* The fluids freely exuded from abraded portions of the bark, as soon as they were thawed by the warmth of the hand, or by removal to a warm room. The branches of the Pinus tœda,—some of them more than half an inch in diameter,—were found to be so brittle as to snap under a very slight degree of flexure. The fluids appeared to be congealed; for no gum exuded from the fractured extremity until it was brought into a warm atmosphere. These observations were repeated, and extended to other perennial plants, on the morning of the 31st of January, 1851,—when the temperature of the atmosphere was 13·5° Fahr.—with *precisely identical results.* It is almost needless to state, that the roses, pines and other plants examined were uninjured.

(*To be continued.*)

ART. XI.—*On the Drift of Lake Superior;* by E. DESOR.*

THE region of the great lakes may be considered as the head-quarters of the North American drift. From the mouth of the St. Lawrence to the borders of Lake Superior, there is hardly a spot where the detrital formations are lost sight of. They generally form low, level plains, but sometimes rise in high bluffs and terraces, and again merely cap the promontories of the bolder cliffs. Throughout this long line of inland country there is, however, no place where they are more extensive than on the southern shore of Lake Superior—more especially its southeastern coast. There, they not only constitute the only visible formations for nearly one hundred miles, but they also attain an astonishing thickness, so as to form, by themselves, ridges and cliffs which exceed in height even those of the Pictured Rocks—being in some places (for example, at the Grand Sable) not less than three hundred and sixty feet high. In consequence of this preponderance of the drift deposit, that portion of the shore of the great lake is the least attractive in a picturesque point of view—it being in the nature of the detrital deposits to soften down the contrasts, and to produce uniformity and monotony. The drift is less conspicuous along the western portion of the lake shore, although it is not wanting even among the romantic and precipitous cliffs of the Pictured Rocks and the Red Castles.

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The drift of Lake Superior may be divided into four different deposits, which, in an ascending order, exhibit the following characteristics:

1st. A layer of coarse materials, composed of pebbles intermingled with loam, which we will designate as coarse drift.

2d. A layer of clay resting either on the coarse drift, or, where this is wanting, on the rock. This is the drift clay of Lake Superior.

3d. A deposit of sand, gravel, and pebbles, irregularly stratified, resting upon the clay, or sometimes upon the rock itself.

4th. A considerable number of isolated boulders, scattered over the whole region, forming the uppermost portion of the drift deposits. The polished and grooved surfaces which occur in connection with the drift constitute, likewise, a most important feature in its history. Finally, there are the drift terraces and ridges, which likewise deserve a close examination, in order to ascertain their bearing in reference to the changes of level which have taken place during and since the drift epoch.

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* From the Report of Messrs. Foster and Whitney; revised for this Journal by the author.

1. *Coarse drift.*—This deposit is the least conspicuous of all. It is found only in a few places along the southern shore of Lake Superior, generally capping the high towering cliffs of sandstone, (as, for example, at the Red Castles, west of the Portage, and also at the top of the Pictured Rocks.) It is generally a mixture of loam and fragments of rock of different size—sometimes worn, but more generally angular. As a leading feature, we may state that it is almost exclusively composed of fragments of the rocks *in situ*, showing that, whatever may have been its origin, it could not have been acted upon by long continued agencies. After a careful examination, I found but few foreign pebbles, mostly of trap, scattered through the mass, and evidently derived from the neighborhood. The whole mass is nowhere more than thirty feet thick. We ought to add further, that in many places the pebbles may be seen disappearing gradually, and the whole passing into a regular drift clay.*

2. *Drift clay, or red clay.*—This deposit was long ago recognized as a peculiar one, distinct from the drift-gravel and sand above it, and the coarse drift beneath it. It has been described by the geologists of the Michigan state survey as the "tertiary clay of Lake Superior." From its red color, which is one of its leading features, it is also called by some "red clay." It is difficult to determine its average thickness, from the fact that, in many places where it is highly developed, it sinks below the waters of the lake, and in other cases, where its base is visible, its top has been partly washed away. There are, however, some places (for example, at the western portion of the Grand Sable) where it may be seen undisturbed in its natural position, its base resting on the almost horizontal strata of red sandstone, a few feet above the water, whilst its top is covered by a considerable mass of drift sand. I found the deposit in this place to be sixty feet in thickness, and exhibiting distinct lines of stratification. Its upper limit may be here seen stretching in a horizontal line for a long distance. We may well consider this locality as indicating the average thickness of the clay. However distinct the upper limit of the clay may be in general, it is also seen in many localities alternating with the sand above, or passing gradually into it—thus showing that both deposits, although of different materials, belong, nevertheless, to the same formation, and therefore that there is no real ground to consider the clay as being a part of the tertiary formation. As far as its composition is concerned, it appears to be a mixture of loam and clay, and its color is owing to the decomposition of the red sandstone and trap from which it has been derived. Though the main mass of the clay

* This deposit might, perhaps, seem hardly worth mentioning, were it not that its peculiar structure and its position remind us of a similar deposit widely diffused throughout New England, especially in the mountainous districts of Vermont, where it forms the most conspicuous feature of the drift.

stratum is composed of very finely comminuted substances, and oftentimes reduced to an almost impalpable powder, yet there are many pebbles interspersed through it, and even boulders of considerable size, generally rounded and smoothed. Fragments of metallic ores and native copper occur occasionally in it—the latter sometimes weighing several hundred pounds. It was by means of the fragments of copper scattered through the clay that the attention of the early travellers was first attracted to the copper mines of that region, which are now so extensively wrought.

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As to its extent, it appears, from what we know, to be spread over an immense tract of country. Not only is it found along the whole southern coast of Lake Superior to Fond du Lac, and along the St. Louis river as far as geologists have extended their investigations, but it occurs also on the north shore, where it has been traced for a considerable distance along several rivers which empty into the lake. It was observed, however, by Mr. Whittlesey, that to the northwest of Lake Superior the drift assumes an ash-colored tint, which is owing, no doubt, to the absence of red sandstone in these regions.

If we were to consider merely the position of this clay as it appears on the southern border of Lake Superior, forming, as it does, a regular stratum, resting upon the red sandstone, and being limited to a certain height, where it is followed by the drift sand, we might well conclude that it was deposited in a circumscribed basin. This is, indeed, the impression which a traveller might receive if he were merely to coast around the lake. Such an impression would be, however, entirely erroneous; for, in ascending the highlands which rise behind those cliffs, we meet again with the same clay at an elevation of from six to eight hundred feet—as, for instance, near the Jackson location on Carp river, and in several places along the road leading to it. It also forms lofty cliffs on the river Ontonagon. In all these places its composition is the same as along the lake shore, being quite as comminuted, and forming the same sticky loam when wet. It ought to be observed, however, that, on the whole, it seems to be limited merely to the depressions of the soil, and never to cover the culminating points.

3. *Drift sand and gravel.*—This is the most widely diffused of all the drift deposits along the shore of Lake Superior, as well as over the whole northern part of the country. It not only covers the clay deposit in most of the localities where the latter has been observed, but also extends over many places where this does not reach. We have stated that the clay, even at its highest level, was generally limited to the depressions. The drift sand and gravel have no such limitations. It is found on the uplands and along the slopes of the hills, as well as in the depres-

sions. Although separated from the drift of the western prairies by the dividing ridge between the upper peninsula of Michigan and Wisconsin, yet in many places, where the ridge is not of considerable elevation, it may be seen passing directly from one slope to the other, especially on the southeastern corner of the lake. It is likewise said to pass from one slope to the other at the southwestern border between the lake and the headwaters of the Mississippi. It is found on the highest summits of the Pictured Rocks—nearly two hundred feet. Its relation to the drift clay can be easily ascertained merely from the state of the roads and trails, which are generally dry and pleasant on the drift sand.

No rule obtains as to the composition of the drift sand and gravel, either in reference to the size or the mineralogical character of the materials.

Layers of fine sand alternate in every possible way with layers of pebbles—sometimes by a gradual transition, at others rather abruptly. The pebbles themselves are composed of all kinds of stone—some from the immediate neighborhood, others from places more remote. They are generally rounded and smoothed, showing that they must have undergone a prolonged and violent motion, such as could have taken place only in the water. The same is the case with the boulders imbedded in the mass, of which there are many of considerable size—from five to six feet through. Many of the boulders are also covered with scratches, such as could have been produced only by a violent and steady rubbing. We would state, besides, as a further peculiarity of the drift pebbles and boulders, that they are generally clean, there being no loam or mud attached to them—a peculiarity which is in itself sufficient to distinguish the gravel drift from the loam deposits of coarse drift before described. The thickness of the drift-sand and gravel, like that of the clay, is best ascertained along the shore of the lake. There seems to be a sort of antagonism as to the relative thickness of both deposits between the eastern and western portions of the lake shore. Whilst the clay seems to assume its greatest thickness west of Keweenaw Point, the sand and gravel seem most developed to the east of that point. Its greatest thickness we found to be at Grand Sable, where the coast rises, according to Mr. Whitney's barometrical measurement, 360 feet above the lake; and since the clay stratum underneath is only sixty feet thick, it gives an amount of three hundred feet for the sand and gravel deposit. From that spot the same drift may be seen extending in the form of a high cliff to the southeast, generally some miles distant from the lake shore; until it reaches it again at Pointe Iroquois, where it rises almost to the same height—345 feet; thence it sinks gradually towards the Saut. As a further peculiarity of the drift-sand and gravel deposits we would mention their irregular and undulating surface, especially where they cover wide tracts of country: as, for instance, in the plains of Wisconsin and Illinois, which from this feature, have been denominated *rolling prairies*, in opposition to the level prairies, which are mostly alluvial. The shores of Lake Superior are, in this respect, less striking—owing, no doubt, to the fact that the country is less level, and also in consequence of the forests which almost everywhere cover the ground. The summit of the Grand Sable, as will be noticed subsequently, is the place where this undulating appearance is most striking on the lake shore.

There can be no doubt that, as a whole, the drift sand and gravel is a stratified deposit, although the stratification is perhaps more imperfect than in any other sedimentary formation. The strata are generally most distinct where the mass is composed of fine sand. They are less conspicuous in the gravel, except where it alternates with layers of sand or clay, in which case the separation into layers is sometimes very distinct. As a frequent occurrence, we would especially mention those irregular layers which have been designated under the name of *cross-stratification* by some, and of *discordant stratification* by others. There may be sometimes seen in a single section, three, four, five, and even more planes of stratification, forming among themselves all sorts of angles—some horizontal, some slightly inclined, and others almost vertical. Instances of such stratification are to be seen all along the coast of Lake Superior, in the drift as well as in the alluvial sand. They are less frequent where the deposits assume a more loamy character. It is well known that this discordant stratification is not limited to the quarternary deposits, but occurs in sandstone of every age. Along Lake Superior, where the drift deposits rest immediately on the Potsdam sandstone, it is a rather impressive sight for a geologist to witness, this structure both in the oldest and most recent of the sedimentary formations, side by side, thus showing that the same laws of deposition, even in minor details, have prevailed at all times in the formation of the earth's crust. Some doubt still exists as to the cause of these singular stratifications. The attention of geologists was first directed to them in the recent deposits of the valley of Switzerland, where two rivers (the Rhone and Arve) meet. They were ascribed by M. Necker to the disturbance caused by the meeting of two currents of variable strength, contending with each other in the same bed, whence the strata resulting from this conflict were called *stratifications torrentielles*. In this way the Swiss geologists succeeded in explaining, not only the variable inclination of the strata, but also their difference of materials, when it happens that one of the currents carries coarser substances than the other. It is evident, however, that this explanation does not apply to the similar structure of the sand deposits along the sea and lake shore, where the conflict is no longer caused by rivers, but by the contending forces of waves and currents. We know, for instance, that in some shallow harbors—that of Charlestown, for example—the pilots have to make out the channel after every severe gale. This shows that the waves exert a strong influence upon the bottom, where it is shallow enough to come within their reach; and since, from the nature of the waves, we must suppose their action to be broken and unsteady, we might well expect such irregular strata to be formed wherever the waves and tides come in conflict. Along Lake Superior there are no tidal currents, as far as we know; but the currents resulting from the changes of the wind are strong enough to account for similar conflicts. If this explanation be true, we might then expect such discordant stratification wherever the water is shallow enough to allow the bottom to be stirred up by the waves. Indeed, there is every probability that all sand and sandstone formations which exhibit a similar structure have been formed in shallow water—an inference which, as far as the drift is concerned, is confirmed by other considerations, which we shall examine hereafter.

4. *Boulders.*—Of all the drift deposits, the boulders have, from all times and in all countries, excited the greatest interest, in consequence of their size, as well as of their position. The mere view of a huge block of granite, situated, as it often happens, on the summit of a hill, whilst the rock on which it rests is of limestone or sandstone, is sufficient to excite the curiosity of every thinking man, as to the place from which this stranger may have come, and as to the mode by which its transportation was accomplished. We ought not to be astonished, therefore, that most of the theories which have been imagined to solve the problem of the drift should refer chiefly, if not exclusively, to the boulders. From looking at them in a too exclusive point of view, most geologists have misunderstood their true signification; they have overlooked the other more regular deposits with which they are connected: thus forgetting that the boulders form but a part of the drift formation, and represent but one single though striking event in a long period of the earth's history. This we consider the chief cause of the insufficiency of most of the theories. Before we attempt any explanation, our object will be first to examine their peculiarities, as exemplified in the region of Lake Superior—which we deem the more important, as this region seems to have been the point of departure for many of them, scattered far and wide over the country. Boulders of every size and description occur in great numbers along the whole southern shore, and are said to be as numerous along the north shore. As a whole, they did not strike me by their dimensions. They do not by any means equal those huge masses found in Switzerland and in many parts of New England. The largest boulder which

I noticed was one of hornblende, near Carp river, measuring fifteen feet in length, eleven in width, and six and a half in height; another, near the Portage, measured eight and a half feet in length and five in width. On the borders of Lake Superior, as in all other countries where drift occurs, the boulders are the most widely diffused. They are scattered over the whole country, and may be seen at all heights, where no other drift deposits reach. They are truly the vanguard of the drift formation, in height as well as in space. Even the dividing ridge, where it rises the highest, does not limit their extent; for they have been found as high as one thousand feet above the lake south of the Anse, and may from thence be traced uninterruptedly along the southern slope of the ridge into the prairies of Wisconsin and Illinois. As to their mineralogical composition, there is every variety of rocks to be found, and in many instances they may be traced to their origin at no very great distance. We thus soon accustom ourselves not to look any longer upon them as strangers, as we do where there is no analogy whatever between them and the rocks on which they rest. Among the most numerous boulders along the lake may be mentioned those of granite, trap, and hornblende rocks, which are common to both shores. Boulders of sandstone are less frequent, in spite of the great predominance of this rock along the south shore—a circumstance easily accounted for by its greater softness, which renders it the more destructible. As a general rule, it may be stated that most of the boulders scattered over the Lake Superior region have not come from far. This is of the utmost importance, since it actually enables us to trace the route which they have followed; and as to their direction, I feel no hesitation in affirming that most of the boulders within the region of Lake Superior have been transported from north to south. As instances of this southerly transportation, I shall state the following facts. The iron region of Lake Superior is situated near Carp river, east of Keweenaw Point; and, although the ridges where the iron ore occurs are only some ten miles from the shore, yet there is not a single boulder, nor even pebble, of iron to be seen north of the ridges. This ore, of which there are innumerable fragments scattered at the foot and in the immediate vicinity of the ridges, is so conspicuous, from its banded structure, that it would undoubtedly have been noticed, if it did occur at all north of its origin. In going from the iron ridges towards the south, iron pebbles and boulders occur in abundance, and may be traced for some distance. Thus, in September last, Mr. Whitney, starting from the ridges east of the Jackson location, traced boulders of iron ore all along his route towards the Esconaubee river, some twelve miles off; and they might probably be found still further south, were it not for the swampy character of the country. This southerly transportation is further confirmed by the boulders of the beach itself, which point likewise to the north as their birth-place. This applies especially to the copper region west of Keweenaw Point. There trap and sandstone are the only rocks in place; and yet among the boulders scattered over the surface there are many of granite and hornblende, which have evidently their origin on the opposite shore, where we know these rocks to be very abundant. Thus it happens that, when travelling from south to north, the appearance of a new formation is always indicated by the occurrence of single boulders of it, whilst nothing of the kind takes place when travelling from north to south. This precession of the boulders is especially striking among the ridges of the iron region north of Carp river, where there is often a great variety of structure in the rocks of the different ridges. There the valleys between the different ridges contain, for the most part, boulders from the next ridge to the north. There are also instances where a ridge did not allow the fragments of the preceding ridges to pass. A striking instance of this has been observed by Mr. Hill west of Jackson location, where the slate and iron boulders are heaped up in great quantities on the northern slope of a greenstone dyke, whilst there are none on the granite slopes south of this dyke, which has therefore acted as a barrier, preventing their transportation farther south. This limitation prevails, however, only within the hilly portion of the Lake Superior region, between the lake shore and the dividing ridge. South of the ridge nothing of the kind seems to occur. There being no further barrier to check their course towards the south, they have travelled even to the very limit of the drift deposit; and thus it happens that boulders of the Lake Superior region are found as far south as the Ohio—that is to say, more than six hundred miles from the dividing ridge, the nearest place from which they could possibly be derived. We think, therefore, that there is satisfactory reason to consider the region of Lake Superior, and especially the rim of cliffs and hills which surrounds its basin, as the birth place of the greatest quantity of boulders scattered over the western States of the Union between the Alleghany mountains and the Mississippi; and from this consideration, the region of Lake Superior, more than any other, deserves a close attention on the part of the geologist who attempts to solve the problem of the drift of this country. By far the greatest quantity of boulders on Lake Superior, as well as elsewhere, are situated on the surface, above all other drift deposits. This, of course, is in itself a proof that they have been deposited posteriorly to these formations. But because they are of a more recent origin, this does by no means prove that they are disconnected from the other drift deposits. We have seen that an abundance of boulders is to be found both in the drift clay and sand of Lake Superior. The only difference between them is, that whilst those of the surface are often more or less angular, those imbedded in the clay and sand are generally more rounded, and often scratched and striated—a peculiarity which we shall afterwards attempt to explain. Now, as the boulders within the drift are of the same kind as those of the surface, and have, like them, a northern origin, (though sometimes not a great way off,) we are naturally led to the inference that they were transported by the same agencies, which must, therefore, have been at work during the deposition of the drift period. Moreover, these agencies must have been as powerful at the time of the drift and clay deposits as afterwards, since we know that many of the included boulders are as massive and as heavy as those of the surface. It is evident, therefore, that no theory can be admissible which does not at the same time account for the transportation both of the boulders of the surface and those of the drift sand and clay.

5. *Grooved, scratched, and polished rocks.*—Whatever opinion we may entertain as to the cause and origin of the drift, there is a point upon which all geologists who are familiar with the subject agree, viz: that there is an unquestionable connection between the drift deposits and the rounded, smoothed, and grooved appearance of the rocks upon which they rest. Wherever drift occurs, it is associated with that peculiar appearance of the ledges, which is instantly recognized. The surfaces are the more perfect, as the rocks are harder and less prone to disintegration. Thus in our district they are most distinct on the trap and compact slates; less so on the granite and compact limestone; and are not expected to be found on the sandstone. Again, in many places the striæ and furrows have disappeared in consequence of the disintegration, and there remains nothing but the rounded outline of the rocks, which, from their resemblance to fleecy clouds, have been called, in the Alps, fleecy rocks.

In many instances the polished and grooved surfaces are concealed by the drift, and are not visible until by some means the deposit is removed. This explains sufficiently why so general a phenomenon should have been for so long a time overlooked by geologists; for it is only about forty years since it was first mentioned, and only ten years since it was brought into general notice. One striking peculiarity of the rocks subjected to erratic agency consists in the fact that, while one side is smoothed down, the opposite side is rough and angular, as if it had been sheltered from the abrading process. These are known as the lea and strike sides. By means of this feature we are enabled to recognize the direction in which the erratic agency operated, even where there are no scratches. The lea side is invariably to the south over the whole of this district—a feature which we ought to expect, when we consider the origin of the groovings.

As a leading feature of all groovings, we may mention their straight course. Whatever the direction, they are in straight lines, whether continuous or interrupted—thus showing that they must have been formed by an agency unyielding and steadily applied. There is but one instance where curved striæ have been observed in this region, which will be noticed hereafter.

Groovings of all sizes occur. The most common form is that of parallel furrows from one to two and four lines wide—sometimes extending but a foot, at others many yards. Where the rock is excessively hard they are mere striæ, which are often as distinct and sharp as though they had been graven with the point of a diamond. Hollow spots are observed, as though they had been scooped out by a round instrument; also, we observe wide bowl and trough-shaped depressions, which have been caused by the same agency, since they are always found parallel with the striæ. Instances of all these different forms exist on both shores of the lake and on Isle Royale.

As to the direction of the striæ in this district, it will be seen that, with the exception of a few local deviations, it is northeast and southwest—a direction which also prevails along the western shore of Michigan, and in portions of the western States. This direction forms a striking contrast with that which prevails throughout New England. There, they bear northwest and southeast. We shall hereafter attempt to explain this singular opposition in the striæ of the two regions east and west of the Alleghanies, and show their relation to the leading features of the continent.

6. *Terraces and Ridges.*—The terraces and ridges of the great lakes have of late attracted a good deal of attention, inasmuch as they have a direct bearing upon the question of the changes of level which the surface is supposed to have undergone during the epoch of the drift. They may be seen both on the south and the north shores of Lake Superior, though they are less striking here than around the lower lakes, (Erie and Ontario.) Those of the north shore of Lake Superior have been described by Mr. Logan. They are most conspicuous at a locality called "Les Petits Ecrits," of which Mr. Eliott Cabot has given a fine sketch in his Narrative. Those of the south shore have thus far been but little noticed, probably because they occur chiefly in that portion of the lake-district which is least visited, viz.: between the Saut and Keweenaw Point. Beyond that point, there may be seen, in many places, along the shore of the copper region, high bluffs of drift; but they nowhere assume that stair-like form which is the characteristic feature of terraces.*

* To avoid confusion, it may not be inappropriate to explain what is meant by the terms terrace, bluff, and ridge, as we shall have to allude frequently to them in the following descriptions. Drift bluffs, or cliffs, are those accumulations of loose materials which terminate abruptly in steep slopes. The steepness of the slope de-

In a geological point of view, the terraces are the most important, since they afford direct evidence of the changes of level which have occurred since the deposition of the drift. There can be no doubt that, wherever terraces of stratified materials are found above each other, the waters have once stood at so many levels. It might be, and indeed it has been, inferred from this, that when terraces occur along a shore, they ought to be found everywhere of the same size; and hence, that when their level is irregular, it is a proof that the upheaval was not uniform. This view, although correct in principle, is, however, apt to lead to mistakes when applied without discrimination.

The error in this respect arises from the fact that terraces have been too often mistaken for, or confounded with, mere beaches. It should not be lost sight of, that terraces and bluffs are the result of the undermining action of the waves. Their size and shape must therefore be determined by the force of this agency. If a basin of water is so situated as to have one of its shores exposed to the full force of gales, while the opposite shore is sheltered by high lands, we may easily conceive of a subsidence of the waters from a higher to a lower level, without at all altering the slope of the coast. In the mean time, the right shore, not being protected, will be so acted upon as to occasion a succession of terraces. Again, the destructive action may be so effective in certain places as to wash off, in the course of time, even the terraces of former levels, and to leave only a single bluff.

There are many places along the lake shore where the peculiar shape of the terraces and their diversity are to be ascribed to such a process. The annexed diagram will render this still more evident. There can be no doubt that the water once stood at the foot of the upper terrace, *m*, and that, while stationary, the upper bluff was formed. Afterwards, the water-level sank, and another bluff was formed at *n*, and still later, another at *o*. The subsidence of the water must have been intermittent—the epochs of subsidence, which are indicated by the areas between the terraces, being followed by intervals of quiet, during which the terraces were formed. But this regular succession of terraces does not extend far. It is limited to a

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pends in most cases chiefly upon the kind of materials of which the bluff is composed. Thus, bluffs of clay are steeper than bluffs of loam, and bluffs of loam steeper than bluffs of sand or gravel. The term terrace is applied when several such slopes are seen one above the other, so as to appear like the steps of a staircase. Ridges differ from terraces in having a double slope, and being, therefore, real hills; whereas bluffs and terraces are merely the margins of plateaux.

small space in our diagram; and as we advance towards the left, we see the intervals between the terraces growing more and more narrow, till they completely disappear—being, as it were, crowded into a single bluff, B. Further on, we see the bluff itself increasing rapidly in height, and by-and-by disappearing entirely, leaving nothing but a gentle uniform slope, A. In the above instance, the circumstance that these different forms of terraces occur within a narrow space, and pass gradually into each other, excludes at once the idea of a change of level. It must be evident to any one that they cannot but be the result of local causes. But, should they occur at great distances, such differences might easily lead to error, and in the present case we might infer that the three terraces *m*, *n*, *o*, were raised at three successive intervals. Thus, not taking into account the action of the waves, and the position of the shores in reference to the predominant winds, (as exemplified in our diagram,) we might perhaps be induced to recur to extravagant hypotheses, call in aid even the trap dykes, and other paroxysmal agencies, to account for features which are most readily explained by the mere play of meteorological agencies.

However, we do not pretend to assert that the upheavals which laid bare a great portion of the drift deposits have been uniform throughout. We know that there are, in almost every drift country, undoubted proofs of local changes of level afforded by the drift terraces; and we shall have occasion hereafter to refer to such an origin for those differences of level which are to be traced in an uninterrupted manner over vast tracts of country, especially along the sea shore. But we should be careful to call in such causes only when the phenomena cannot be otherwise explained.

Ridges are often associated with terraces, and have frequently been confounded with them. They differ from terraces in being actual hills, rising from a plain, with a slope on each side. Sometimes they extend for a long distance along the shore of the sea, or an inland lake—as, for instance, Lakes Erie and Ontario, where they are commonly used as roads, being dryer than the surrounding grounds. From their situation, as well as their position, these ridges have the greatest analogy to ancient beaches, and there can be no doubt that many of them have no other origin. In that case they are the most reliable evidence for ascertaining local changes. Beaches have almost uniformly gentle slopes, rarely exceeding 12°; but there are among the ridges some which are too high, with slopes too abrupt, to be considered as mere beaches. Since attention was first attracted to them in Sweden, where they go by the name of *œsars*, (which means sand hills,) I shall designate them henceforth by that name. There is every probability that they were formed as shoals, or bars, or banks, under water, rather than on the border of the coast, since we know that such ridges are forming in our day in shallow water both in the sea and large lakes. It ought to be remembered that the summit of these submarine ridges is not always even, nor their bearing necessarily horizontal; so that a slight inequality in their outlines, especially if limited to a narrow space, does no more imply a local change of level than in the case of the terraces before mentioned. Since, from the nature of things, raised beaches and œsars are expected to occur in the same localities, it must be left to the sagacity of the observer to determine in each case to which class they belong. Instances of both have been noticed, at numerous points, along the shores of the lower lakes, but they are less frequent on the coast of Lake Superior, although not entirely wanting.

Conclusion.—It is not intended here to give a general theory of the causes and origin of the drift, since it would oblige us to allude to many phenomena foreign to the district under consideration, and to discuss the many systems which have been proposed by various authors to solve this great problem. I shall, therefore, limit myself, for the time, to a brief sketch of the principal periods which may be recognized among the drift deposits of Lake Superior. A mere glance at the relative position and structure of the drift deposits, as described in the foregoing pages, will suffice to prove that the phenomena neither indicate a paroxysmal agency, nor the operation of a single cause, however long continued. They disclose a long series of events, which have resulted from causes highly diversified, and as yet but imperfectly known. We recognize the following periods in the history of the drift of Lake Superior:

1. The period of the grooving and polishing of the rocks must be considered as the dawning of the drift epoch. At the close of the tertiary era, (which has left traces of its presence over many of the States bordering on the Atlantic, as far north as the island of Martha's Vineyard, in Massachusetts,) the whole northern portion of the continent was subjected to the operation of a general and most powerful agency, of which there is no precedent in the history of former geological ages. There may be found in every sedimentary formation, deposits similar in their composition to those of the drift, but the rocks on which they rest are nowhere characterized by those peculiar markings which we have described as glacial furrows and striæ. In the region of Lake Superior, they are found at all levels—over plains, and on the slopes of the hills and mountains. Even the dividing ridge between the upper peninsula and Wisconsin exhibits traces of their action. It is proved that here, as well as in Europe, their main direction has been from north to south—being, however, some-

times deflected either to the east or to the west. These deflections are, no doubt, dependent upon the leading physical features of the country. Along the south shore of Lake Superior we have found them running mostly from northeast to southwest, a direction parallel with that of the principal ridges—as, for instance, those of Isle Royale and Keweenaw Point. These coincidences would be still further strengthened, if it could be ascertained by a series of soundings across the lake, that the main troughs run in the same direction.

We know, in the actual operations of nature, of no agent capable of producing such a gigantic result as the shaving and smoothing of a whole continent. To those who are familiar with the effects produced by glaciers upon the walls and bottoms of the valleys through which they move, it cannot be denied that they exhibit the closest analogy to the phenomena which we have been describing. The appearance of the rocks, as well as the form and size of the striæ, is the same; yet it must be remembered that, in our days, glaciers occur chiefly in the valleys of the highest mountain chains.* It is, therefore, difficult to conceive how they could exist and move in a wide and level country, like the northern parts of the United States and Canada. In order to avoid this difficulty, it has been assumed that the whole northern hemisphere, as far as erratic phenomena reach, was once covered with a general cap of ice, similar to that of the circumpolar region, which in its southerly progression, is supposed to have at once smoothed the rocks and transported the boulders from north to south.† A careful examination of the position of the boulders, which I have found, both in this country and northern Europe resting mostly on stratified deposits of sand or clay, has convinced me that the above assumption is no longer admissible, so far as it relates to the transportation of the boulders. The remaining question relates to the grooving and polishing of the surface rocks. However inclined I may be, from personal observation of the glacial phenomena both in Switzerland and Scandinavia, to refer the groovings to this agency, according to M. de Charpentier's theory, (which is also advocated by M. Agassiz,) I shall refrain from entering into any discussion of the subject, for the reason that the laws which regulate the motion of the polar ice are as yet too little known to be made the basis of geological speculation in a report like this, the object of which is to state facts and give particular information. Whatever may

* I have shown elsewhere that the glaciers of the Alps are as much dependent upon the orographical features of the Alps, as upon the climate. See Comptes Rendus, de l'Académie des Sciences.

† As to the difficulty arising from the climate, I would remark that it has been most ingeniously shown, in a recent paper by M. Lecoq, that if polar glaciers have ever existed in these latitudes, it was possible only with a higher temperature.

have been the cause of the groovings, it must be admitted that an agency which was capable of shaving off and wearing down such an extent of surface must also have been able to remove the detritus and to transport it from one place to another. I am inclined to ascribe this agency, and to consider as contemporaneous with it, that portion of drift materials which I have described as coarse drift, and which, wherever it exists, is regularly found at the base of the stratified deposits, having been left undisturbed by the waters of the subsequent period.

2. We have shown that almost everywhere along the southern shore of Lake Superior there is a stratum of red clay resting on the coarse drift, or, where this is removed, on the polished rocks. From its thickness and the comminuted state of the materials, we infer that during its deposition a long interval of time elapsed, characterized by no violent agitations. With this stratum begins the second era of the drift. As to the boulders distributed through it, we may suppose that they were transported by floating ice, in the same manner as their transport is at this day effected every spring from the borders of the northern lakes and rivers, and dispersed over the adjacent swamps and low lands.

3. We have found everywhere resting upon the clay of Lake Superior a stratum of gravel and sand, which, notwithstanding its irregular structure, is a real stratified deposit and must therefore be supposed to have been formed in water. Occurring at still higher levels than the drift clay, and attaining sometimes a thickness of several hundred feet, we must suppose that at the time of its deposition the country had subsided to a still lower level. From the diversity of its stratification we infer that this period was characterized by intervals of agitation and repose. According to Mr. H. D. Rogers's ingenious theory, this feature should be ascribed to the temporary operation of earthquake waves, such as are known to occur occasionally in our days, especially in the Pacific. Such waves might well have disturbed the bottom of the ocean, carrying before them an immense freight of detrital materials, which were heaped up in irregular masses and hills, resembling the drift accumulations.

I consider, as belonging to the close of this period, the transportation of those huge boulders which are scattered in such vast profusion over the surface of the gravel deposits, and which we have detected on the very summits of the anticlinal axis, where no other drift deposits occur. It might thus appear, at first that this epoch had been characterized by more violent agitations than the preceding one. We should be careful, however, not to judge of the power and violence of an agency merely from the size of the materials transported; for, if the boulders had been conveyed by powerful currents, we should not only find them of diminished size in their progress southward, but also rounded and smoothed like the smaller pebbles. On the contrary, we know that they are just as massive at the very limits of the drift in Ohio, as near their birth-place; besides, many of them along the anticlinal axis are perched, as it were, on the very top of narrow hills and knobs, where it is hardly admissible that they should ever have been left by a violent agency. Finally, many of them, in spite of contradictory assertions, have rather sharp angles, as if they had been subjected to but slight attrition. I am therefore inclined to suppose that the surface boulders, like many of those buried in the drift-clay and sand, have been transported by floating ice, (not icebergs.) By this hypothesis, their position on the summit of the hills offers no longer any difficulty; for it is natural to suppose that they should have been stranded upon those points, which at the time were shoals. The changes of level which the region of Lake Superior has undergone during the drift epoch are represented in the following diagram. Assuming that, during the period of the groovings, the waters stood nearly at the same level as now, the land must have sunk during the second period to the depth of at least five hundred feet, and again the same amount during the third period, when they reached those summits, which are now one thousand feet above the lake.

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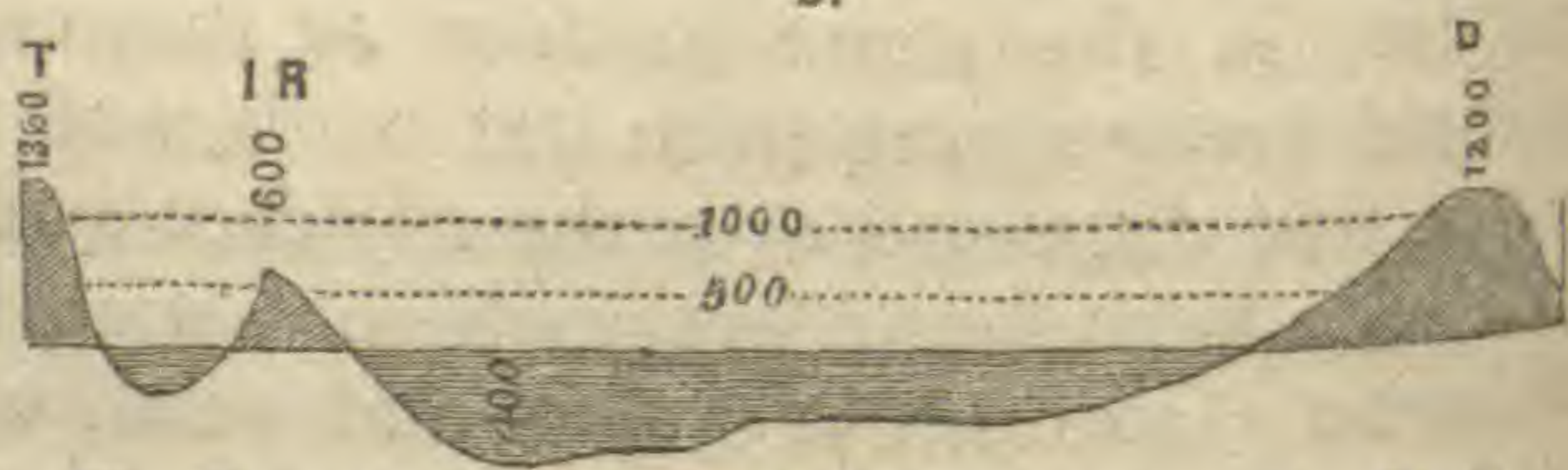

T., Thunder Cape. I. R., Isle Royale. D., Dividing-ridge between Lake Superior and Lake Michigan.

The boulders of Lake Superior, like those of all other parts of the country, point to the north as the source of their origin; yet there is this difference, that they are not generally derived from far. Those along the beach of the south shore have in the main been derived from the north shore, but as a whole they are not very numerous; and I have Mr. Foster's authority for stating that very few have passed beyond the dividing ridge. The boulders and pebbles of the opposite slope of the axis, although more numerous than on the northern slope, are all derived from the dividing ridge itself. The same is true to a great extent of those scattered over the plains and prairies of Wiscousin and Illinois. This ridge, abounding in eruptive and metamorphic rocks, is therefore to be considered henceforth as the true birth-place of the boulders scattered over the Western States, and we need no longer recur to high northern latitudes to ascertain their origin.

The drift epoch may be considered as closed with the transportation of the boulders. The waters, after having thus reaching their highest level—during which the transport of the boulders and pebbles was accomplished—again subsided. With this subsidence commences the era of the alluvium. We have no reason however, to suppose that the subsidence was sudden. Everything leads us to believe, on the contrary, that it was gradual, and that the same agencies continued to operate to a certain degree. Thus we may infer that beaches were formed, sand bars built up, and boulders transported, in the same manner as before, although at lower levels. Meanwhile, the former and higher beaches receded more and more from the shores; the bars, shoals, and submarine banks appeared as ridges or œsars above the plains recently laid dry, whilst new ones were forming at lower levels; and whenever the water, in its receding movement, stood for a sufficient time at the same level to allow the new shore to be acted upon and undermined by the waves, these bluffs and terraces were formed, as shown before.

Now, since terraces and ridges occur frequently along the great lakes, they may be considered as a conclusive proof that the subsidence was really gradual. In this respect, terraces and ridges, although composed of drift materials, belong properly to the alluvial period, as well as the denudations along the channels through which the waters are supposed to have been discharged. I shall therefore examine them with more detail in my report upon the alluvium. Thus far, we are not aware of any striking geological event—such as the elevation of a mountain chain—having taken place between the two epochs of the drift and alluvium. It might therefore be asked if there is sufficient reason to separate them. There are, indeed, some geologists who question the propriety of such distinction. My chief motive in adopting it is derived from all of the drift phenomena, rather than from any single event.

The drift is the last phasis of any importance through which the earth passed before it became fitted for the habitation of man. Were it not for these deposits, a great portion of this continent, including the district embraced in this report, would have been a waste of naked and barren rocks, covered partially with heaps of dry sand or rough detrital materials. Through the long continued agency of water, these materials have not only been reduced and dispersed, but also mingled in such proportions as to afford a most appropriate soil for vegetable and animal life. When, afterwards, the rise of the continent caused the waters to recede within their present limits, they left behind them those wide, drift-covered plains, destined to become, in the lapse of time, the seat of an industrious, intelligent, and prosperous nation. We think ourselves justified in considering the period, when the waters, after having done their work, began to recede, as the beginning of that new and grand era which has been properly called the era of *man*, and of which the alluvial period is the introduction.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Magnetic relations of Gases.*—Plücker has studied the magnetic and diamagnetic relations of various gaseous bodies in different states of pressure. The apparatus employed consisted of a delicate balance, the beam of which was of glass and which gave a perceptible deflection with 0·0001 milligramme. The gases examined were enclosed in spheres furnished with stopcocks and attached to one of the arms of the balance; these were capable of resisting an internal pressure of about two atmospheres. The sphere of glass containing the gas was placed over the two half-armatures of a powerful electro-magnet and then the attraction or repulsion measured by means of weights placed in the opposite scale pan. The trifling amount of magnetism in the glass was exactly compensated by the magnetism of the surrounding air. The following were the principal results obtained.

(1.) The specific magnetism of oxygen compared with that of iron as unity was found to be 0·003500.

(2.) Oxygen loses its sensible magnetism in almost all gases where it enters into chemical combination. Deutoxyd of nitrogen, NO_2, is an exception to this rule, its magnetism being $\frac{2}{5}$ths of that of oxygen.

(3.) If we introduce oxygen little by little into a sphere containing NO_2, the magnetism diminishes till the proportion of the two gases is sufficient to form hyponitric acid, NO_4, when the magnetic action becomes insensible. On adding more oxygen the magnetism reappears.

(4.) Hyponitric acid, NO_4, when condensed into a liquid is diamagnetic.

(5.) The magnetism of oxygen, deutoxyd of nitrogen and magnetic mixtures is proportional to the density of the gas.

(6.) A magnetic gas mechanically mixed with any other indifferent gas preserves its magnetism whatever be the density of the mixture, only in the neighborhood of the poles there appears to be to a certain extent a separation of the gases which must slightly augment the attraction of the entire mass.

(7.) A magnetic gas which has been for some moments attracted by an electro-magnet is very readily repelled if the polarity of the magnet be changed. Hence it appears that gases possess a very distinct coercive force.—*Comptes Rendus*, xxxiii, 301; *Pogg. Ann.*, lxxxiii, 87.

2. *Artificial formation of Minerals.*—Ebelmen has published a second memoir upon this subject containing many valuable additions to our knowledge, and throwing great light upon chemical geology and mineralogy. The method pursued in these investigations was the same as that employed by the author in his previous researches and consisted in dissolving the constituents of the mineral to be formed in an appropriate solvent and submitting the whole to evaporation at a high temperature in a porcelain furnace. Boric acid was the solvent commonly employed, but the author also used borax, phosphoric acid and certain alkaline phosphates. Of the minerals belonging to the spinelle group several were obtained by the author in his previous memoir;

the experiments however have been repeated and with better success as regards the size and perfection of the crystals obtained.

Magnesian spinelle Al_2O_3, MgO was prepared by igniting a mixture of alumina, magnesia, chromate of potash and boric acid, the mixture remaining in the furnace eight consecutive days. The crystals thus produced were octahedrons truncated upon the twelve edges; some of them three or four millimeters in the side: they were transparent, of great lustre and of a more less marked rose color. The angles measured perfectly corresponded to the theory: the density of the crystals was 3·542. Gahnite, Al_2O_3, ZnO, was obtained by a precisely similar process in well defined colorless octahedral crystals of density 4·58. By adding a small quantity of bichromate of potash to the mixture, ruby-red truncated octahedrons were obtained of great beauty and lustre. The author points out the fact that the atomic volumes of the two last mentioned compounds correspond almost perfectly, that of the former being 25·2, that of the latter 25·1. Chromite of manganese, Cr_2O_3, MnO, was obtained by igniting together oxyd of chromium, oxyd of manganese and boric acid. The crystals were regular octahedrons of a semi-metallic iron gray color, of density 4·87, and of a hardness sufficient to scratch quartz. Chromite of zinc, Cr_2O_3, ZnO, was procured in the same manner and obtained in the form of small, very brilliant regular octahedrons of a greenish black color, and of density 5·309 at 11 C. The atomic volumes of the chromites were found somewhat higher than those of the aluminites, that of chromite of zinc being 27·5, of chromite of magnesia 27·3, of chromite of manganese 28·7, of chromite of iron 28·3. Ferrite of zinc was obtained in the form of small black brilliant octahedrons, of density 5·132. Its atomic volume is 29·3.

The formation and properties of the artificial cymophane were described by the author in his first memoir. By repeating the experiment with the addition of carbonate of lime to the mixture of alumina, glucina and boric acid, a perfectly pure cymophane was obtained in transparent crystals 5 or 6 millimeters in length. These crystals have a slightly greenish tint, are hard enough to scratch topaz, and of density 2·759 at 12 C. The crystalline form was found to correspond perfectly with the determinations of Descloizeaux made with the natural mineral; many of the crystals were similar to those found at Haddam, in Brazil and the Ural. The author next describes two new compounds under the names of magnesia-borate of oxyd of chromium, and magnesia-borate of oxyd of iron. The empirical formulas of these compounds are $3Cr_2O_3+2BO_3+6MgO$, and $3Fe_2O_3+3BO_3+6MgO$; the author proposes the rational formulas $3Cr_2O_3+2(BO_3, 3MgO)$ and $3Fe_2O_3+2(BO_3, 3MgO)$. A tribasic borate of magnesia BO_3, 3MgO was obtained by fusing magnesia with an excess of boric acid at a high temperature. The compound forms radiating crystals of a nacreous aspect and very high lustre; its density is 2·987; it is insoluble in water but easily soluble in acids. Peridot, SiO_3, 3MgO, was obtained by fusing together silica, magnesia and boric acid; the crystals were several millimeters in length, perfectly transparent but slightly yellow; their form was an octahedron with a rectangular base deeply truncated upon its two summits. The angles measured agreed perfectly with those of the mineral species. The author points out the interesting fact that the atomic volumes of this compound and the corresponding borate already described are almost identical, viz., 133·8 for the silicate, and 132·3 for the borate. A second silicate of magnesia, $2SiO_3, 3MgO$, was formed in the same manner and exhibited crystals having the form and angles of diopside. Two corresponding silicates of zinc were also obtained in indistinct crystals. A borate of alumina having the formula $(Al_2O_3)^2 BO_3$ was prepared by igniting alumina with borax or by igniting alumina, oxyd of cadmium and boric acid. The crystals were rectangular prisms from six to ten millimeters in length, transparent and colorless and hard enough to scratch quartz. The addition of silica to the mixture prevented the formation of a borate and the alumina then crystallized in large hexagonal crystals of a very high lustre. These crystals are double six-sided pyramids deeply truncated upon their two summits; the measured angles exactly corresponded with those of corundum. The density of the crystals was found to be 3·928 at 20 C.; their hardness was that of corundum and they easily scratched topaz. In this process the silica may be replaced by other substances; carbonate of baryta gave large crystals of the same form; carbonate of soda produced the same effect, and several other bodies were employed without essentially modifying the result. Rutile was obtained in long acicular prisms by igniting a mixture of titanic acid with the phosphate of soda and ammonia; the crystals were transparent and of a golden yellow color; their density was 4·283, which agrees with that of rutile. It will be remembered that Daubrée obtained titanic acid crystallized by the action of the vapor of water upon the chlorid of titanium at a high temperature; the crystals were however identical with Brookite. Niobic and tantalic acids fused with an excess of salt of phosphorus yielded long greenish transparent prisms. The author proposes to examine these acids more completely hereafter.—*Annales de Chimie et de Physique*, xxxiii, 34, *Sept.*, 1851.

3. *Preparation of Tungstate of Soda and Tungsten.*—Wright has discovered a very simple method of preparing this remarkable compound which has attracted much attention from its resemblance to metallic gold. Crystallized dried bitungstate of soda is to be fused in a porcelain crucible over a spirit lamp and to the fused mass metallic tin is to be added in single small fragments. The formation of the crystals instantly commences at the surface of the melting tin and these soon fill the whole mass; the heat should not be greater than is requisite to fuse the bitungstate and the process should last but a very short time if it be desired to obtain large and fine crystals. It is very remarkable that the cubes of the tungstate of soda and tungsten are absolutely infusible at the temperature at which the process is carried on and that the largest crystals do not even appear to be formed in immediate contact with the tin. When the mass has cooled, the gold colored cubes are to be isolated by digesting them alternately with concentrated caustic potash and chlorohydric acid, and then well washed with water and dried. The density of the crystals was found to be 6·617, they are perfect conductors for the electric current; analysis gave 93·8 per cent. of tungstic acid which corresponds to Wöhler's formula, $WO_2, WO_3+NaOWO_3$.—*Ann der Chemie und Pharmacie*, lxxix, 221.

4. *Phosphuret of Tungsten.*—Wöhler has described a remarkable compound of tungsten with phosphorus, prepared and analyzed in his laboratory by Wright. Impure phosphoric acid containing lime is to be mixed in coarse powder with tungstic acid, in the proportion of 9 of phosphoric to 2 of tungstic acid, and the mixture is to be ignited in a charcoal crucible for an hour, at a temperature at which metallic nickel becomes perfectly fused. On cooling, the crucible is found to contain a hollow mass of gray phosphuret of tungsten, lined upon the inside with the most brilliant crystals. These crystals have a dark steel color, with a remarkably brilliant metallic lustre; they are six-sided prisms, apparently of the same form as gypsum; their density is 5·207; they are perfect conductors of the electric current. In contact with zinc in dilute acid they evolve hydrogen, and in a solution of a salt of copper they become covered with metallic copper. The phosphuret is unchanged at the temperature in which manganese fuses; heated to redness in the air it undergoes scarcely any change; heated upon charcoal in a current of oxygen, it burns with great brilliancy, yielding a deep blue sublimate upon the coal. In the same manner it burns with fused chlorate of potash; acids exert no action upon it. Wright found the constitution of this compound to correspond with the formula PW_4.—*Ann. der Chemie und Pharmacie*, lxxix, 244.

5. *Telluret of Ethyl.*—Mallet has discovered the remarkable fact that the telluret of ethyl enters into combination, like an organic radical, uniting directly with oxygen, sulphur, &c. Telluret (tellurid) of ethyl heated with warm nitric acid, is dissolved with evolution of nitric oxyd. If the solution be evaporated to dryness, a white crystalline mass remains, which is soluble in water, and when heated, burns like gunpowder. Mallet infers from its general relations that its constitution is $C_4H_5TeO+NO_5$. Sulphuretted hydrogen produces in a solution of this salt an orange colored easily fusible precipitate, probably C_4H_5TeS. When chlorohydric acid is added to a solution of tellurid of ethyl in nitric acid, a colorless, heavy oil is separated, which possesses an offensive odor and may be distilled without change, though at a very high temperature; Mallet found its constitution expresssed by the formula C_4H_5TeCl. Treated with oxyd of silver, the chlorid of the new radical yields chlorid of silver, and the oxyd of tellurethyl, C_4H_5TeO remains in solution and may be obtained by evaporation, as a colorless, highly crystalline mass. The new oxyd in solution has an alkaline reaction; heated in a tube, it is decomposed with separation of metallic tellurium and an offensive oil. In the air the oxyd burns with a blue flame; sulphurous acid separates tellurid of ethyl; chlorohydric acid precipitates the chlorid in colorless drops. With chlorid of platinum the oxyd of tellurethyl gives a yellow, with chlorid of mercury, a white precipitate; with chlorid of ammonium, a salt is obtained having the formula $C_4H_5TeCl+2NH_4Cl$, and crystallizing in the form and with the angles of gypsum.—*Ann. der Chemie und Pharmacie*, lxxix, 223.

6. *On white Precipitate.*—Wagner has found that white precipitate is readily acted upon by amyl-mercaptan, the products of the action being sulphid of mercury and chlorid of amyl-ammonium; the reaction is represented by the equation $NH_2Hg_2Cl+C_{10}H_{12}S_2=2HgS$

$+NH_3(C_{10}H_{11})Cl$. Wagner suggests that triethylamin may be formed by the action of sulphid of ethyl upon the nitruret of mercury, NHg_3, and that decompositions of a similar character promise to throw much light upon the constitution of ammonia and amid compounds.—*Journal für praktische Chemie*, liii, 378.

7. *Quantitative separation and determination of Phosphoric Acid.*—REYNOSO has proposed a method of separating phosphoric acid quantitatively, based upon the fact that phosphate of peroxyd of tin is insoluble in nitric acid, while other phosphates are soluble. A weighed portion of pure tin is to be introduced into a balloon with the phosphate, nitric acid added in excess, and the whole boiled. When the whole of the tin has been oxydized the mass is to be thrown upon a filter, washed, dried, heated to redness over a spirit lamp, and weighed. The difference between this weight and the weight of peroxyd of tin yielded by the tin employed, gives the weight of the phosphoric acid. The filter must be carefully burned, a few drops of nitric acid being added to prevent reduction. The flame of the lamp must also be carefully managed so as not to mount too high, and finally the mass must be rapidly weighed, as it is very hygroscopic. The process gave good results when applied to the analysis of pyrophosphate of soda, the only compound which Reynoso appears to have examined.—*Comptes Rendus*, xxxiii, 385.

8. *Propylamine in Plants.*—DESSAIGNES has discovered propylamine in Chenopodium vulvaria. Forty kilogrammes of the plant were distilled with a solution of carbonate of soda. The distillate was saturated with chlorohydric acid, evaporated to dryness, and treated with strong alcohol, which left a large quantity of salammoniac undissolved. The alcoholic solution was precipitated by bichlorid of platinum; the precipitate by recrystallization gave large reddish orange crystals, which were found to have the formula NC_6H_9, $HCl+Pl\,Cl_2$.—*Comptes Rendus*, xxxiii, 358.

9. *Sulphid of Nitrogen.*—FORDOS and GÉLIS have published an elaborate investigation of the sulphid of nitrogen obtained by the action of ammonia upon perchlorid of sulphur, and concerning the constitution of which there has been much doubt hitherto. The authors prepare the substance in question by passing ammonia into a solution of perchlorid of sulphur in eight or ten times its volume of bisulphid of carbon. In this process sal-ammoniac is first deposited; then a cochenille-red compound, partly soluble in the liquid, but soon disappearing to give place to a brown matter which in its turn disappears. When this happens the process is finished. The liquid is now to be filtered and allowed to evaporate spontaneously, when the sulphid of nitrogen crystallizes. The mother liquor contains sulphur; the mass on the filter is a mixture of sal-ammoniac and sulphid of nitrogen, which may be separated by treatment with boiling bisulphid of carbon. Sulphid of nitrogen as thus prepared, presents transparent crystals of a beautiful golden yellow: the crystals, according to Nicklès, belong to the right rhombic system. The powder of the sulphid of nitrogen has a brilliant yellow color; when rubbed or struck with a hard body it explodes with great violence; brought into contact with an ignited body it fuses without explosion; heated in an oil bath to 157° C., the sulphid explodes, yielding nitrogen

and the vapor of sulphur. Sulphid of nitrogen has little or no odor, but it strongly irritates the mucus membranes when brought into contact with them. In water it is insoluble; alcohol, ether and turpentine dissolve small portions of it; bisulphid of carbon is its best solvent. The composition of the sulphid of nitrogen was found to be expressed by the formula NS_2. Boiling water decomposes the bisulphid of nitrogen; the reaction is expressed by the equation

$$4NS_2+15HO=S_2O_2,\ NH_4O+2(S_3O_5,\ NH_4O)+NH_3.$$

Caustic potash in like manner produces decomposition; the final products of the action are expressed by the equation

$$2NS_2+3KO+6HO=S_2O_2,\ KO+2SO_2KO+2NH_3.$$

The bisulphid of nitrogen unites directly with the two chlorids of sulphur and forms with each several distinct compounds. The authors assign to three of these combinations the formulas $Cl\,S+NS_2$, $Cl\,S+2NS_2$, $Cl\,S+3NS_2$.—*Ann. de Chemie et de Physique*, xxxii, 389.

10. *On a class of ammoniacal compounds of Cobalt.*—CLAUDET has described a new base containing cobalt and the elements of ammonia. Ammonia is to be added in excess to a solution of proto-chlorid of cobalt mixed with four times its weight of chlorid of ammonium. The solution rapidly absorbs oxygen from the air, and if placed in a bottle so as to fill it about half and repeatedly agitated, removing the stopper from time to time to renew the air, the absorption is complete in a few days and the liquid changes from dark brown to an intense violet red. By boiling the solution strongly acidulated with chlorohydric acid, a heavy crimson powder is deposited. When cold, the liquid is decanted and the precipitate washed by decantation, thrown on a filter and dried. To obtain it crystallized, it may be dissolved in boiling water, to which a few drops of chlorohydric acid have been added; on cooling, the salt is deposited in the form of small sparkling ruby-red octahedrons. The new salt is sparingly soluble in cold water, more soluble but slightly decomposed in boiling water; the decomposition may however be prevented by adding a few drops of chlorohydric acid. Chlorohydric acid and the chlorids of ammonium and sodium completely precipitate the salt from its solutions: sulphuric and nitric acids partially transform it into sulphates and nitrates; potash and soda decompose the solution, evolve ammonia and throw down a hydrated peroxyd of cobalt. Sulphuretted hydrogen precipitates the whole of the cobalt as a bisulphid. The analyses of the new salt led to the formula $Co_2Cl_3N_5H_{16}$, so that its formation may be represented by the equation $2Co\,Cl+NH_4Cl+4NH_3=Co_2Cl_3N_5H_{16}$. These elements may obviously be grouped in various ways; perhaps the most probable is the following: $Cl\,N\left\{\begin{matrix}H^2\\Co^2\end{matrix}\right.+2Cl\,N\left\{\begin{matrix}H_3\\NH_4\end{matrix}\right.$, admitting with Graham that NH_4 may replace hydrogen. With chlorid of platinum the salt yields a buff-colored silky precipitate, $Co_2Cl_3N_5H_{16}+2Pl\,Cl_2$. With chlorid of mercury it gives a bulky silky precipitate of red needles represented by $Co_2Cl_3N_5H_{16}+6HgCl$. Oxyd of silver throws down the chlorine from the salt and yields a highly alkaline liquid, which on standing a few hours is decomposed; the solution contains the oxyd of the new base $Co_2O_3N_5H_{16}$. The author has obtained

several salts of this oxyd which are not described. The chlorid $Co_2Cl_3N_5H_{16}$, when ignited in a current of hydrogen, yields pure metallic cobalt; ignited per se, it yields the protochlorid mixed with a little oxyd, from which it is easily separated by solution and filtration. Claudet recommends the preparation of this salt as a means of obtaining chemically pure cobalt compounds direct from the ores. The discovery of this class of cobalt compounds is due to Dr. Genth; it is understood that Frémy is engaged in a complete investigation of them. —*L. and E. Phil. Mag., Oct.*, 1851. W. G.

II. Mineralogy and Geology.

1. *Mineralogical Notices;* by W. P. Blake.—*Chlorite.*—Having received fine cleavage specimens of the Achmatowsk chlorite,* I have examined them by polarized light and find indications of a uniaxial character; the symmetrical cross was clearly visible in all the plates subjected to examination. This confirms the observations of those who have examined the chlorites, and proves them to be rhombohedral or hexagonal in crystallization. There can no longer be any doubt of the anomalous optical character of the Chester Co. (Pa.) mineral, which I have named *Clinochlore.*†

Red Sapphire.—I have discovered a new locality of this mineral, in the township of Vernon, Sussex Co., N. J., where it occurs in the well known white crystalline limestone of that region, and with the associated minerals it appears to constitute a true vein of segregation. As the minerals have been but recently removed, there has not been time to bestow on many of them the examination they require, and therefore a brief notice only can be given at this time. The sapphire is remarkable for its irregular "ragged" form, which is best seen in those crystals, which were obtained from the soil where atmospheric agencies had removed the calcareous investment, and left the sapphire with its thin and ragged excrescences entire. The color of the finest specimens is "ruby red," others have various shades of purple:—they are translucent, no *transparent* specimens having been obtained.

The associated minerals are remarkable for their beauty and peculiarity; the following list embraces those which occur in greatest abundance: Red spinel, rose spinel, chondrodite, hornblende, iron pyrites, phlogopite, graphite, hydrous sesquioxyd of iron, hydrous silicates of alumina. The following minerals occur sparingly: Rutile, sphene, ilmenite, zircon, blue fluor, and emerylite.

Argentiferous galena.—Mr. C. M. Wheatley has recently opened rich veins of this ore near Phœnixville, Chester Co., Pa. With the galena the following minerals have been observed: *Sulphate of lead*, in large crystals; *Carbonate of lead*, in splendid crystallizations; *Phosphate of lead*, of a fine green color in good crystals; *Chromate of lead*, in small crystals associated with pyromorphite and cerasite, usually implanted upon the dark green pyromorphite, forming beautiful cabinet specimens.

* Received from Prof. J. D. Dana, who had them from Joseph A. Clay, Esq., of Philadelphia.

† This Journ., xii, p. 339, 1851.

Chalcotrichite.—This beautiful mineral was found by Mr. C. M. Wheatley, filling small cavities in the sulphuret of copper from the Perkiomen copper mine. It was formerly obtained from the Perkiomen lead mine.

Sulphuret of Nickel.—Sulphuret of nickel occurs in Lancaster Co., Pa., associated with massive chrome iron, emerald nickel, and a massive "violet talc," in which it is imbedded in small grains and nodules.

Lievrite.—Lievrite has been found in Monroe, Orange Co., N. Y., at the O'Neil iron mine, in long blade-like crystals, upon crystals of magnetite.

2. *On the Angles of Eumanite;* by J. E. Teschemacher, (from a letter to one of the editors, dated Boston, Nov. 11th.)—By careful management I have obtained the following measurements of my crystals of eumanite, by *usual* reflection with my goniometer.*

$$\left.\begin{array}{l}\breve{e} \text{ on } \bar{e}',\ 108^\circ \\ \bar{e}' \text{ `` } e',\ 140^\circ\ 15'\end{array}\right\} \text{ on the smaller crystal.}$$

$$\left.\begin{array}{l}e' \text{ `` } e'',\ 159^\circ\ 30' \\ \breve{e} \text{ `` } o,\ 128^\circ\ 15'\end{array}\right\} \text{ on the larger crystal.}$$

3. *On the Silurian System of Central Bohemia;* by M. Barrande, (Bull. Soc. Geol. de France, viii, [2], 150, Jan., 1851.)—M. Barrande, in his observations on the Silurian System of Central Bohemia, recognizes an upper and a lower Silurian corresponding to what has been made out, first in England and since in Russia and America. Each of these divisions contains four subdivisions or groups, which he letters A, B, C, D, and E, F, G, H. The lower Silurian consists almost wholly of siliceous and argillaceous rocks, to the nearly total exclusion of limestones; the upper consists mainly of limestones. The limit between the two is marked by eruptions of trap of great extent, which alternate with graptolite schists, in which twenty species of graptolites have been detected. Trilobites analogous to those of the Caradoc sandstones and Llandeilo flags, (corresponding to subdivision D) abound in the lower division, while in the upper, great numbers of Cephalopods, Gasteropods, Brachiopods and Acephala occur, families hardly represented in the lower Silurian of Bohemia.

The groups A and B are without fossils, or *azoic*, and have together a thickness of 24 to 26,000 feet. A is composed of semi-crystallized and argillaceous schists, and B to a great extent of conglomerates alternating with argillaceous schists; they pass almost insensibly into one another. C consists mainly of greenish argillaceous schists, and is not over 1300 feet thick. Its fossils are mostly trilobites, and they are peculiar in having the thorax very much developed, with the pygidium very small; the principal genera are *Paradoxides*, *Elliptocephalus*, *Conocephalites*, &c. The group D, called also the *quartzite* division, abounds in siliceous as well as argillaceous rocks, and is very rich in trilobites. Its vertical extent is 8 to 10,000 feet.

The several subdivisions from C upward are each distinct in their fossils. Not a species of C occurs in D, and even the genera of trilobites are mostly distinct. The extinction of the fossil species of C, is referred to ejections of porphyry and other igneous rocks.

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* For figure, see last volume of this Journal, page 397.

M. Barrande points out the existence of what he calls *colonies* of the upper Silurian interpolated in the D group of the lower Silurian. They are beds sometimes 100 yards thick, having the upper Silurian character in the fossils. M. Constant Prevost observed, on the conclusion of M. Barrande's remarks, that if the existence of such *colonies* can be admitted as proved, (which must require still more investigation,) it indicates a synchronism between two different marine formations, and shows that extended systems of cotemporaneous beds may be palæontologically distinct, while at the same time, beds of successive ages may be identical in their fossils.

M. Barrande stated it as his belief, that the granites which surround the Bohemian Silurian basin are subsequent in age to the schistose formations.

4. *Examination and Analysis of the Ball Coal of the Burdwan Mines ;* by HENRY PIDDINGTON, Curator Museum Economic Geology.—The Museum is indebted for this specimen to D. Williams, Esq. the Government Geologist, who informs me that these balls are very common among the Burdwan mines, though I am not aware that they have ever been noticed before. He says they are of all sizes, from that of a cannon ball, to a man's head, and even 18 inches in diameter.

Like the Burdwan, and many English kinds of coal, these balls are composed of alternate layers of a bright bituminous and a dull jetty kind of coal, splitting easily between the layers. Our specimen was very tough and difficult to cut with a saw. There was no difference between the center and the periphery of the ball, nor anything that could give the idea of a nucleus or of concentric layers.

And upon considering it attentively it will be seen at once that it is nothing more than an oblique rhomboidal prism of the common coal of the mines, rounded *somehow* into a rough ball. So far, for the present as to its external characters.

I find its specific gravity to be 1·37. The mean of 5 specimens of Burdwan Coal, according to Mr. Prinsep, is 1·365. I place here its analysis and the mean of the first six specimens in Mr. Prinsep's table.

	Analysis of the Ball coal.	Mean of Burdwan coal. Mr. Prinseps's table.
Water,	5·00	7·4
Volatile matter,	29·00	35·6
Carbon,	57·00	52·5
Ash,	9·00	12·2
	100·00	

There was a slight excess in my analysis ; no doubt due to the peroxydation of the iron.

5. *Gold in Australia.*—The gold region of New South Wales, situated in the mountain south of west from Sydney, in the Bathurst District, appears from the reports still to promise well. From Sydney papers we learn that the existence of gold was first predicted by Rev. W. B. Clarke, who has long been engaged in investigating the geology of the country. His opinion was based upon his knowledge of the character and position of the rocks, and he early recommended exploration in

the main Australian range along the meridian of 149°, where gold has been found. Rev. Mr. Clarke states the singular fact that just 90° west of the auriferous range in Australia, we find an auriferous band in the Urals; and just 90° west of the Urals occur the auriferous mountains of California.

III. Zoology.

1. *On the Classification of the Crustacea Corystoidea;* by James D. Dana.—The Corystoidea have their closest relations with the Cancroidea, and form a passage between this division of the Brachyura and the Hippidea. They are remote from the Oxystomata in the mouth and efferent branchial channels, the latter having these channels *medial* over the palate, and the former *lateral* like the Cancroids. In the projection of the outer maxillipeds over the epistome, the elongated and more or less pilose outer antennæ, and the partially free or less closely inflexed abdomen, the species exhibit their degradation below the Cancer type. The Platyonychidæ are the Cancroids which approximate most to the Corystoids, and they are placed with this group by De Haan. But they differ from the Corystoidea in the shorter and more naked outer antennæ; and we therefore incline rather to retain them with the Crancroidea, where they are arranged by Milne Edwards.

The degradation of the Cancroidea is also seen in another line leading through *Acanthocyclus* to *Corystoides*, Lucas, and *Bellia*, Edw.* The last two genera are somewhat Corystoid in habit: yet they pertain to a distinct group, inasmuch as they have the outer antennæ obsolete or nearly so, and the inner antennæ *without fossettes.* This last character belongs only to the lower Anomoura and the Macroura, and places these genera quite low in rank in a group we name Bellidea which belongs near if not among the Anomoura.

In attempting to arrange the Corystoidea into groups, we consider, as in other cases, the relations of the species to the higher Crustacea, and by the transitions observed, we are led to our subdivisions. *Trichocera* is Cancroid in habit, in the absence of a beak, in the nearly naked outer antennæ, and in having the outer maxillipeds fitted neatly to the epistome. *Thia* and *Kraussia* are also without a beak, like the Cancroids, but have the outer maxillipeds overlapping the epistome. The remaining genera have the front somewhat rostrate, the inner antennæ longitudinal, the maxillipeds produced over the epistome and the outer antennæ elongate and pilose and flexed at base towards the medial line. The form of the third joint of the outer maxillipeds varies from narrow oblong to transverse in closely related genera, and affords no basis for a family distinction.

* In the synopsis of the Cancroidea in this Jour., vol. xii, p. 131, Corystoides was placed near Acanthocyclus, to which it has close relations; but from this and the other Cancroids, it is removed by the absence of all power of retraction in the inner antennæ.

The name *Bellia* has been recently duplicated in the science, in an article by Mr. C. Spence Bate, on a new genus of Amphipods near Lepidactylis, published in the Annals and Mag. Nat. Hist., [2], vii, 318, pl. 11, f. 8, 1851. The description of Milne Edwards's genus of this name is published in the Ann. des Sci. Nat. [3], ix, 1848, p. 192.

The following are the families thus deduced, with the genera of Corystoidea and their characteristics.

Fam. I. TRICHOCERIDÆ.

Carapax formâ Cancroideus, fronte non rostratus. Antennæ internæ longitudinales. Antennæ externæ breves, flagello parce piloso. Maxillipedes externi super epistoma non producti, sed margini areæ buccalis bene adaptati.

Gen. Trichocera, *DeHaan.**—Frons dentatus. Articulus maxillipedis externi 3tius apice truncatus. Articulus antennarum externarum 1mus elongatus, hiatum orbitæ bene occupans.

Fam. II. THIIDÆ.

Carapax suborbicularis, non oblongus, fronte non rostratus. Antennæ internæ transversæ vel obliquæ. Antennæ externæ breves, flagello parce piloso. Maxillipedes externi super epistoma producti.

Gen. 1. Thia, *Leach.*—Frons integer, arcuatus. Antennæ internæ transversæ. Pedes nulli natatorii. Articulus maxillipedis externi 3tius vix oblongus.

Gen. 2. Kraussia, *Dana.*† Carapax paulo transversus, margine postero-laterali brevi, fronte denticulato, medio emarginato. Antennæ internæ obliquæ. Pedes 8 postici natatorii, tarso falciformi. Articulus maxillipedis externi 3tius vix oblongus.

Fam. III. CORYSTIDÆ.

Carapax sive suborbicularis sive multum angustus, fronte plus minusve rostrato. Maxillipedes externi super epistoma producti.

1. *Pedes nulli natatorii.*

G. 1. Telmessus, *White.*‡—Carapax parce transversus, pone medium latior, fronte paulo producto et medio emarginato. Articulus antennarum externarum 1mus elongatus, processu elongato hiatum orbitæ bene occupans. Articulus maxillipedis externi 3tius parce oblongus apice triangulatus, articulum 4tum prope apicem gerens.

G. 2. Atelecyclus, *Leach.*§—Carapax fere orbicularis, lateraliter arcuatus, fronte paulo producto. Articulus antennarum exter-

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* Faun. Japon. (1833), p. 16.

† Ad species complectendum *Xantho integrum* DeHaanii, (Faun. Japon. 66, tab. 18, f. 6) et *Platyonychum rugulosum* Kraussii ("Südaf. Crust." 26, tab. 1, f. 5), Thiæ affines et Xantho remotas, genus "Kraussia" institutum est. Platyonycho discrepat margine postero-laterali breviore quam antero-lateralis, carapace paulo transverso, fronte bilobato et denticulato, flagello antennarum internarum subpiloso. An *Trichocera porcellana* (A. White, "Voy. Samarang," p. 59) a Kraussii specie differt?

‡ A. White, "Ann. Mag. Nat. Hist.," xvii, 497, 1846; Voy. Samarang, 14, tab. 3. *Atelecyclo*, habitu, antennis aliisque, Kraussia affinis: ejus affinitas Maioideis, ab Adamsio White edita, justa non videtur.

§ *Chlorodius* DeHaanii, Faun. Japon., 13.

narum 1mus elongatus hiatum bene occupans. Articulus maxillipedis externi 3tius oblongus, apice oblique truncatus, in marginis interni emarginatione articulum 4tum gerens.

G. 3. PELTARION, *Hombron et Jacquinot.**—Carapax suborbicularis, ante medium latior, fronte triangulatè rostrato. Articulus antennæ externæ 1mus perbrevis, 2do parce crassior. Articulus maxillipedis externi 3tius non oblongus, apice truncatus. Articulus pedum 8 posticorum 5tus 4to vix brevior.

G. 4. PSEUDOCORYSTES, *Edwards.*—Carapax suborbicularis, parce oblongus, triangulatè rostratus. Articulus maxillipedis externi 3tius vix oblongus. Articulus pedum 8 posticorum 5tus 4to duplo brevior.

G. 5. GOMEZA, *Gray.*†—Carapax oblongus, fere ellipticus, triangulatè rostratus. Oculi parvi vel mediocres. Articulus maxillipedis externi 3tius vix oblongus vel transversus, apice truncatus. Articuli pedum 8 posticorum 5tus et 4tus fere æqui.

G. 6. OEIDIA, *DeHaan* (partim).‡—Carapax oblongus, antice non angustans, fronte breviter rostrato. Oculi permagni. Articulus maxillipedis externi 3tius latus, oblongus, 2ndo paulo brevior. Articuli pedum 8 posticorum 5tus et 4tus fere æqui.

G. 7. CORYSTES, *Latreille.*—Carapax oblongus, rostratus. Oculi mediocres. Articulus maxillipedis externi 3tius angustè oblongus 2do vix brevior.

2. *Pedes postici natatorii.*

G. 8. DICERA, *DeHaan.*§—Carapax oblongus, rostro late triangulato. Pedes postici natatorii, tarso falciformi. Articulus maxillipedis externi 3tius angustè oblongus, 2do parce brevior.

2. *Conspectus Crustaceorum, &c.—Conspectus of the Crustacea of the Exploring Expedition under Capt. Wilkes, U.S.N.;* by JAMES D. DANA. —PAGURIDEA, (Proc. Acad. Nat. Sci., Philad., 1851. p. 267.)—This paper contains a distribution of the Paguridea into genera, and also a description of new species. The natural groups have been partly indicated by Milne Edwards in his work on Crustacea, and more lately in the Annales des Sciences Naturelles for 1848, p. 59. There are, however, in his arrangement, discrepancies between the characters of the species and those laid down for his subdivisions which we find it difficult to explain. Such are, the placing of *Pagurus tibicen* and some related species with his "*Æquimanes*," when the left hand is very much the larger, and the *guttatus* and *granulatus* with the "*Senestres*," although the hands are nearly equal in the former, and the right is the larger in the latter. Still his sections are in the main natural groups, and some of them have more important points of distinction than this distinguished author has mentioned.

* *Hombron et Jacquinot*, "Voy. au pole Sud," tab. 8, f. 1.

† *Oeidia* DeHaanii (partim), Faun. Japon. 15. Species Oeidiæ typica (*O. 20-spinosa* denominata) *Gomeza* vera est.

‡ Faun. Japon. 15. Species *Oeidia distincta* DeHaanii, typus est generis Oeidiæ accepti. Genus idem est *Jonas*, (Hombron et Jacquinot, "Voy. au pole Sud," tab. 8, f. 4–8.) Species *J. macrophthalmus*, oculis grandibus formâ characteribusque aliis, *Oeidiæ distinctæ* ferme similis.

§ Faun. Japon. 14, (1833). *Nautilocorystes*, Edwardsii, Crust. ii, 149 (1837).

The *Pagurus Bernhardus* is the type of one group the species of which live mostly in the colder oceans. This genus is called BERNHARDUS, and the common species naturally bears Leach's specific name, *Bernhardus streblonyx*. The 2d genus is called DIOGENES; *Pagurus miles* is the type. The 3d, PAGURISTES, having for its type, *Pagurus gonagrus* or *P. pilosus*. The preceding have the fingers acuminated, while in the following genera they are spoon-excavate at tip. The 4th genus is PAGURUS, a large group including *P. punctulatus*, having corneous tips to the fingers, and no beak; the 5th, CALCINUS, with *P. tibicen* as the type, with calcareous tips and a short beak; [6th, ANICULUS, equal handed and beaked, and with corneous tips to the fingers like the following, but having a vertical movement in the fingers, as in *Pag. aniculus*;* 7th, CLIBANARIUS, equal-handed and having a lateral or horizontal movement in the fingers, as in *Pagurus clibanarius*. The last two genera are here for the first time published, not being included in the paper in the Academy's Proceedings.—D.]

The following is a synopsis of the genera:

FAM. I. PAGURIDÆ.

Antennæ internæ mediocres, articulo 1mo brevissimo. Maxillipedis externi palpus flagello multiarticulato instructus.—Species aquaticæ vel littorinæ.

1. PAGURINÆ.—Abdomen asymmetricum.

1. *Digiti acuminati. Flagellum antennarum internarum sæpe plus minusve pilosum.*

Gen. 1. PAGURISTES, (*D.*)—Pedes 4ti non subcheliformes, tarso terminali. 2–4 appendicibus pone pedum posticorum bases instructus. Basis antennarum internarum paulo longior, apice articuli 2di extremitatem oculorum fere attingente.

Gen. 2. DIOGENES, (*D.*)—Pedes 4ti subcheliformes. Pedes 1mi inæqui, sinister major. Annulum ophthalmicum rostriferum. Appendicibus pone pedum posticorum bases carens.

Gen. 3. BERNHARDUS, (*D.*)—Pedes 4ti subcheliformes. Pedes 1mi interdum subæquales, sæpius dexter major. Annulum ophthalmicum non rostriferum. Appendicibus articulatis pone pedum posticorum bases carens.

2. *Digiti instar cochlearis excavati. Flagellum antennarum internarum nudum vel nudiusculum.*

Gen. 4. PAGURUS.—Manus anticæ sæpius compressæ, interdum subæquæ, sæpius sinistrâ majore; digitis apice corneis, in plano verticali claudentibus. Frons medio non rostratus sed truncatus.

Gen. 5. CALCINUS, *D.*—Manus anticæ compressæ, inæquæ, sinistrâ majore, digitis apice calcareis, in plano verticali claudentibus. Frons medio breviter rostratus.

Gen. 6. ANICULUS, *D.*—Manus anticæ subæquæ, digitis apice corneis, in plano verticali claudentibus. Frons medio breviter rostratus.

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* The Pagurus aniculus may hereafter be named *Aniculus typicus*.—D.

Gen. 7. CLIBANARIUS, *D.*—Manus anticæ plus minusve depressæ, subæquæ, digitis apice corneis, in plano horizontali claudentibus. Frons medio breviter rostratus.

II. CANCELLINÆ.—Abdomen symmetricum.

Gen. CANCELLUS, *Edwards.*

FAM. II. CENOBITIDÆ.

Antennæ internæ multo elongato, articulo 1mo oculis sæpius longiore, valde deflexo. Maxillipedis externi palpus flagello non instructus.—Species subterrestriales.

Gen. 1. CENOBITA, *Edw.*—Corpus angustum, carapace elongato, fronte non rostrato. Abdomen in cochleam retortum, superficie plerumque carnosum.

Gen. 2. BIRGUS, *Leach.*—Corpus latum, carapace parce oblongo postice latissimo, fronte triangulato. Abdomen directum, laminis crustaceis dorso plerumque tectum.

The following are the names of the species described in this paper: Bernhardus Novi-Zealandiæ, B. armatus, B. hirsutiusculus, B. pubescens, B. tenuimanus, Paguristes longirostris, P. hirtus; Pagurus fabimanus, P. scabrimanus; together with the following referred to Pagurus, but which pertain to the new division Clibanarius, C. æquabilis, C. zebra, C. humilis, C. globoso-manus. The last may be the P. corallinus of Edwards. Also Cenobita carnescens and C. brunnea. D.

3. *On the Genus Orthostoma;* by JAMES D. DANA.—The genus Orthostoma was referred by its describer, Dr. Randall, (J. Acad. Nat. Sci., Philad., viii, 121, pl. 5, 1840,) to the family Gecarcinidæ. In its convex or obese form, it approaches that group. Yet the dentate antero-lateral margin, and thin dentate front led to his remarking that "the species has at first sight much resemblance to the Cancers." Upon examining the specimens, recently, in the collections of the Academy at Philadelphia, I find that in their essential characters as well as the texture of the carapax, the species is related to the Telphusidæ. The male verges are situated as in Telphusa, and not as in the Grapsoidea; and in general habit, the described species is near Potamia and Trichodactylus. It has the 2d joint of the outer maxillipeds oblong (but little shorter than the second), with the summit oblique, and the 4th joint articulated with it near the outer apex. The male abdomen is very broad triangular, and 5-jointed.

The known genera of Telphusidæ, are, then, as follows:—

G. 1. TELPHUSA, *Latr.*—Articulus maxillipedis externi 3tius subquadratus, 2dus multo brevior, 4tum angulo apicali interno gerens.

G. 2. VALDIVIA, *White.*—Articulus maxillipedis externi 3tius oblongus, 2dus transversus. [Carapax margine antero-laterali 4-dentatus.] Pedes longi.

G. 3. POTAMIA, *Latr.*—Articulus maxillipedis externi 3tius subquadratus, apice subtriangulatus anguloque apicali 4tum gerens.

G. 4. TRICHODACTYLUS, *Latr.*—Carapax marginibus subinteger. Articulus maxillipedis externi 2dus oblongus, 3tius vix oblongus, subtriangulatus, margine terminali valde obliquo anguloque externo 4tum gerens, 2ndo multo brevior.

G. 5. ORTHOSTOMA, *Randall.*—Carapax margine antero-laterali dentatus. Articulus maxillipedis externi 2dus oblongus, 3tius oblongus, 2do paulo brevior, apice obliquus, prope angulum exteriorem articulum 4tum gerens.

4. *Genus Heterograpsus of Lucas.*—The genus Heterograpsus, described in the recent work on the Exploration of Algiers, and figured on plate 2 of Crustacea, f. 4, has the outer maxillipeds and most other characters of *Pseudograpsus*, Edw.,* but differs from that genus in having the sides nearly straight and convergent backward as in most Sesarmæ, instead of arcuate. In the species described, the *H. sexdentatus*, the antero-lateral margin is bi-emarginate. J. D. D.

5. *On Recent Researches into the Natural History of the British Seas;* by Prof. EDWARD FORBES, (Proc. Roy. Soc., Feb. 14, 1851, p. 17.)—The Natural History of the British Seas has for a long time been a favorite subject of investigation. Within the last fifteen years, however, fresh inquiries have been set on foot, and the details of their zoology and botany worked out to an extent beyond that to which the examination of any other marine province has been carried. Numerous and beautifully illustrated monographs, treating of their fishes, Cetacea, portions of the Articulata, the Mollusca, Radiata, Zoophytes, Sponges, and Algæ, have been published, either at private cost, or by patriotic publishers, or by the Ray Society, such as the scientific literature of no other country can show. As these have all been the results of fresh and original research, they present a mass of valuable data sufficient to form a secure basis for important generalizations.

From these materials, and from the results of the enquiries into the distribution of creatures in the depths of our seas, conducted by a committee of the British Association, a clear notion may be formed of the elements of which our submarine population is composed. Extensive tables, exhibiting the sublittoral distribution of marine invertebrata, from the South of England along the Western coasts of Great Britain to Zetland, mainly constructed from the joint observations of Professor E. Forbes and Mr. Mac Andrew, are now preparing for publication, as a first part of a general report from the committee referred to. The data embodied in these tables are the produce of researches conducted during the last eleven years, and registered systematically at the time of observation.

British marine animals and plants are distributed in depth (or bathymetrically) in a series of zones or regions which belt our shores from high-water mark down to the greatest depths explored. The uppermost of these is the tract between tidemarks; this is the LITTORAL ZONE. Whatever be the extent of rise and fall of the tide, this zone, wherever the ground is hard or rocky, thus affording security for the growth of marine plants and animals, presents similar features, and can be subdivided into a series of corresponding sub-regions; through all

* See this Journal, xi, 278.

of which the common limpet (*Patella vulgata*) ranges, giving a character to the entire belt. Each of these sub-regions has its own characteristic animals and plants. Thus the highest is constantly characterized by the presence of the periwinkle *Littorina rudis*, (and on our western shores, *Littorina neritoides*,) along with the sea-weed *Fucus canaliculatus*. The second sub-region is marked by the sea-weed *Lichina* and the common mussel (*Mytilus edulis*). In common with the third sub-region it almost always presents rocks thickly encrusted with barnacles; so that where our shores are steep, a broad white band, entirely composed of these shell-fish, may be seen when the tide is out, marking the middle space so conspicuously as to be visible from a great distance. In the third sub-region the commonest form of wrack or kelp (*Fucus articulatus*) prevails, and the largest periwinkle (*Littorina littorea*) with the *Purpura capillus* are dominant and abundant. In the fourth and lowest sub-region the *Fucus* just mentioned gives way for another species, the *Fucus serratus;* and in like manner the shells are replaced by a fresh *Littorina* (*littoralis*) and peculiar *Trochi*.

Once below low-water mark the periwinkles become rare, or disappear, and the *Fuci* are replaced by the gigantic sea-weeds known popularly as tangles (species of *Laminaria*, *Alaria*, *&c.*) among which live myriads of peculiar forms of animals and lesser plants. The genus *Lacuna* among shell-fish is especially characteristic of this zone. In sandy places, the *Zostera* or grass-wrack replaces the *Laminaria*. The LAMINARIAN ZONE extends to a depth of about fifteen fathoms, but in its lowest part the greater sea-weeds are comparatively few, and usually the prevailing plant is the curious coral-like vegetable called Nullipore.

From 15 to 50 or more fathoms we find a zone prolific in peculiar forms of animal life, but from which conspicuous vegetables seem almost entirely banished. The majority of its inhabitants are predacious. Many of our larger fishes belong to this region, to which, on account of the plant-like zoophytes abounding in it, the name of CORALLINE ZONE has been applied. The majority of the rarer shell-fish of our seas have been procured from this region.

Below 50 fathoms is the REGION OF DEEP-SEA CORALS, so styled because hard and strong true corals of considerable dimensions are found in its depths. In the British seas it is to be looked for around the Zetlands and Hebrides, where many of our most curious animals, forms of zoophytes and echinoderms, have been drawn up from the abysses of the ocean. Its deepest recesses have not as yet been examined. Into this region we find that not a few species extend their range from the higher zones. When they do so they often change their aspect, especially so far as color is concerned, losing brightness of hue and becoming dull-colored or even colorless. In the lower zones it is the association of species rather than the presence of peculiar forms which gives them a distinctive character. All recent researches, when scientifically conducted, have confirmed this classification of provinces of depth. When we have an apparent exception, as in the case of the submarine ravine off the Mull of Galloway, dredged by Capt. Beechy and recorded by Mr. Thompson, in which, though it is 150 fathoms deep, the fauna is that of the coralline zone, we must seek for an explanation of the anomaly by inquiring into the geological history of the area in question. In this particular instance there is every reason to believe that the ravine mentioned is of very late date compared with the epoch of diffusion of the British fauna.

When we trace the horizontal distribution of creatures in the British seas, we find that though our area must be mainly or almost entirely referred to one of the great European marine provinces, that to which the lecturer has given the name of CELTIC, yet there are subdivisions within itself marked out by the presence or absence of peculiar species. The marine fauna and flora of the Channel Isles present certain differences, not numerous but not the less important, from that of the south-western shores of England, which in its turn differs from that of the Irish sea, and it again from that of the Hebrides. The Cornish and Devon sea fauna and that of the Hebrides are marked by redundancies of species; that of the eastern coasts of England on the contrary by deficiencies. Along the whole of our western coasts, whether of Great Britain or Ireland, we find certain creatures prevailing, not present on our eastern shores. In the depths off the south coast of Ireland we find an assemblage of creatures which do not strictly belong to that province, but are identical with similar isolated assemblages on the west coast of Scotland. In the west of Ireland we find a district of shore distinguished from all other parts of our coast by the presence of a peculiar sea-urchin, to find the continuance of whose range we must cross the Atlantic to Spain. In such phenomena the lecturer sees evidences of conformation of land, of outlines of coast and connections of land with land under different climatal conditions than at present prevail within our area, for an explanation of which we must go back into the history of the geological past. If we do so, we can discover reasons for these anomalies, but not otherwise.

The dredging researches about to be published, go to show that among our sublittoral animals the northern element prevails over the southern,—a fact indicated by the number of peculiar northern species; at the same time the southern forms appear to be diffusing themselves northwards more rapidly than the northern do southwards. This diffusion is mainly maintained along our western shores, and appears to be in action, not only in the British seas, but also along the shores of Norway. We must attribute it to the influence of warm currents flowing northwards, originating probably in extensions of the gulf-stream. The body of colder water in the depths of our seas preserves the original inhabitants of this area, remnants of the fauna of the glacial epoch, overlain and surrounded by a fauna of later migration, and adapted to a higher temperature. A curious fact respecting the marine creatures of the Arctic seas of Europe, viz., that the littoral and laminarian forms are peculiarly arctic, whilst the deeper species are boreal or celtic, may be explained also by the influences of warm currents flowing northwards and diffusing the germs of species of more southern regions in the coralline and deep-sea-coral zones; for in the arctic seas the temperature of the water is higher at some depth than near the surface. On the other hand, we find in a region farther to the south than Britain, an outlier of the Celtic fauna preserved in the bays of Asturias, where it was discovered in 1849 by Mr. Mac Andrew; a very remarkable fact, and one appealed to by the lecturer as confirmatory of his theory of an ancient coast extension between Ireland and Spain.

There is still much to be done in the investigation of the natural history of our seas, and many districts remain for more minute exploration. It is chiefly among articulate animals and especially among worms that fresh discoveries may be looked for. Yet even now, new and remarkable forms of mollusca may occasionally be procured, and during the autumn of last year in a cruise with Mr. Mac Andrew, no fewer than twenty additional molluscs and radiata were discovered in the Hebrides, and have just been described by the lecturer in conjunction with Professor Goodsir. Among these is one of the largest, (if not the largest,) compound ascidians ever discovered. In our southernmost province, fresh and valuable researches have been conducted during the past year by Professor Acland and Dr. Carus, who selecting the Scilly Isles as a field for exploration, have filled up a blank in our fauna.

The lecturer concluded by an expression of gratification at the spread and progress of natural history studies in Great Britain among all ranks, and at the love of science manifested in the systematic manner in which our fauna and flora have been explored, and the beautiful works which have been produced in illustration of them.

IV. Astronomy.

1. *New Planet Eunomia*, (Astron. Journal, &c.)—Another planet was discovered by M. de Gasparis, of Naples, on the 29th July, 1851. Its appearance was like that of a star of the 9th magnitude, and its apparent place at $11^h\ 44^m\ 53^s{\cdot}7$ m. t. Naples, was R. A. $18^h\ 15^m\ 59^s{\cdot}94$, and Southern declination 26° 3′ 54″.

The following elements of its orbit are published by Mr. G. Rümker of the Hamburg Observatory. They are computed from the Naples observation of July 29, and the Hamburg observations of Aug. 29 and Sept. 27.

1851, October 1·0, Greenwich m. t.

Mean longitude, . .	293° 49′ 51″·49	
Longitude of perihelion, .	27 35 37 ·57	M. Eqx.
" " node, . .	293 52 54 ·76	Jan. 0. 1851.
Inclination, . . .	11 43 42 ·75	
Angle of excentricity, .	10 51 34 ·29	
Excentricity, . . .	0·1884017	
Log. semi axis major, . .	0·4228496	
" mean daily motion, .	2·9157322.	

2. *First Comet of* 1851.—Dr. D'Arrest at Leipsic, discovered a telescopic comet on the 29th of June, 1851, and from the observations of June 29, July 2 and 6, he computed the following elements.

Perihelion passage, 1851, July 6·35816 m. t. Berlin.

Longitude of perihelion, . .	324° 35′ 59″·8	App.
" " Asc. Node, . .	152 41 33 ·2	Eqx.
Inclination, ...	14 43 38 ·8	
Log. perihelion distance, . .	0·0892774	
Motion, ...	Direct.	

M. Yvon Villarceau finds from his computations that this comet is a periodical one, and that its time of revolution is about eight years. There is some probability of its identity with the comet observed in 1678 and computed by Douwes.

3. *Second Comet of* 1851, (Astr. Jour.)—On the first of August, 1851, Mr. Brorsen, at the Senftenberg Observatory, discovered a telescopic comet in the constellation *Canes Venatici.*

The following elements have been computed by Mr. C. W. Tuttle, second assistant at the Harvard Observatory, from the observations there taken August 23, 26, and 29.

Perihelion passage, 1851, Aug. 26·46269 Gr. m. t.		
Long. of perihelion, . .	311° 3′ 38″	M. Eqx. Jan. 0. 1851.
" " node, . . .	215 30 45	
Inclination, ...	37 41 22	
Log. perihelion distance, . .	9·98876	
Motion, ...	Direct.	

4. *Aurora Borealis of September* 29*th*, 1851.—The Auroral display of Sept. 29, 1851, was witnessed in the Southern States to an unusual extent. From a very interesting account of his observations on that occasion, which Prof. Lewis R. Gibbes has published in the *Charleston Evening News*, Oct. 3, 1851, we make the following extract, referring to an hour when in this latitude, the streamers passed our zenith, and extended downward ten degrees or more below the coronal point.

"At ten minutes before 8, a bright and well-defined auroral arch was seen just above the northern horizon, and continued visible more than half an hour, becoming somewhat brighter, and rising a little higher than at first. At 8^h 15^m a sketch of its position was taken. * * This moment proved to be nearly that at which the arch was most brilliant and best defined, and from this position it did not afterwards much vary. The vertex of its upper boundary was about 3° or 4° to the east of a vertical drawn through the Pole Star, and about half a degree lower than the parallel of altitude passing through Alpha of the Great Bear, which was about ten degrees to the west of the vertical; curving from this point downwards to the horizon, on the west it passed about a degree or a little more below Alpha in the Great Bear, and very near Gamma in the same constellation, on the east near Delta in Auriga, and a degree and a half below Capella in the same constellation, its two extremities in the horizon embracing an arc of about 80° of that circle. The breadth of the arch was about equal to the interval between Epsilon and Zeta in the Great Bear. The arch was surmounted with rose-colored or purple-colored rays, of moderate brilliancy, normals or perpendiculars to the arch in their several positions, nearly equal in length, and those near the vertex of the arch reaching about two-thirds the distance from the arch to the Pole Star. The arch itself was of a bright white light, tinged with green, arising perhaps from contrast with the rose-colored rays, the whole forming a really magnificent spectacle, especially for our climate."

5. *Note on the Aurora Borealis of Sept.* 29*th*, 1851; by Prof. J. Le Conte, (from a letter to one of the editors, dated Athens, Geor-

gia.)—There was an unusually brilliant display of the Aurora Borealis at this place on the evening of the 29th of Sept. 1851. It commenced at evening twilight and continued until 11 o'clock at night. The hazy luminous arc from which the streamers proceeded, extended from the north to the northeast point of the horizon, embracing an amplitude of 45° or 50°. The streamers were observed to shoot up to an altitude of 40°. The color varied from orange-red to white. As far as my recollection extends, it was the most magnificent exhibition of the phenomenon I have ever witnessed in *this* latitude (33° 58′). I notice that it was seen as far south as St. Simon's Island in lat. 31°; and it is probable that it was visible as far south as Key West.

6. *Account of a Reflecting Telescope constructed by Mr. Josiah Lyman, of Lenox, Mass.*, (sent for publication in this Journal, by Prof. A. Caswell.*)—Mr. J. Lyman, late Principal of the Academy of Lenox, Mass., has recently manufactured a *Reflecting Telescope*, (finished in June last,) of the following dimensions, and description. The focal length is 16 feet. Aperture 9½ inches in the clear. The tube is composed of thick Russia iron, painted and varnished; the parts being fastened together by brass bands with screws. The arrangement for observation is that of Herschel and Lord Rosse; the finder being placed on the left of the front end of the instrument, (left to a person facing the object viewed,) and the eye-tube on the right. The lower end of the instrument has attached to it a frame-work, terminating in Ys, and resting upon two pivots at the ends of a horizontal axis. In the center of this axis is a socket working upon a vertical axis, rising from the center of a tetrapod which rests upon the ground or floor of the observatory, as the case may be. The front end of the telescope is supported by two legs lengthened or shortened at pleasure, by a combination of cranks, cords and pulleys; the whole so contrived as to allow of every necessary motion with smoothness and uniformity, without any cramping of the parts. With this mounting, the instrument may be either portable or stationary. In the latter case, declination

* Prof. Caswell, in sending the above for this Journal, writes to the Editors as follows:—"The following account of the Reflecting Telescope constructed by Mr. Lyman of Lenox, Mass., has been placed in my hands, with the request that if I approved the same I would forward it for publication in your Journal.

"During the recent meeting of the American Association at Albany, a Committee, of which I was a member, was appointed to examine and report upon Mr. Lyman's telescope. The unfavorable state of the weather prevented their testing its optical power by observations of any of the heavenly bodies, and consequently no report was made.

"I examined the construction, mounting and mechanical adjustments of the instrument, and am happy to say that they appear to me to be very good. The mounting and mechanism are such as to secure steadiness, smoothness, and sufficient freedom of motion. The testimony of Prof. Alexander as to its performance on close double stars is very satisfactory.

"Mr. Lyman deserves great credit for bringing so arduous an experiment to a successful issue. His telescope, in point of optical power, is, so far as I know, much in advance of any thing heretofore achieved in this country. It is no small matter to have constructed an instrument, which, under favorable circumstances, will separate double stars distant from each other by no more than *half a second of arc.* The fact is worthy of being known, and I hope Mr. Lyman, by the success of the present effort, will find encouragement to aim at still greater success.

Brown University, Oct. 17, 1851."

and azimuth and even hour circles, may be used in connection with the foot-piece if desired.

One of the peculiarities of this instrument is, that the large speculum is held in its position by a system of triangles so arranged as to produce perfectly uniform pressure upon the lower surface; and even the slight pressure requisite is mainly counteracted by antagonist pressure upon the face.

But the great excellence of this telescope lies in the remarkably *accurate figure of the speculum.* The singularly sharp outline of the stellar disks, the great clearness of the components of almost the closest multiple stars, the very satisfactory performance on the clusters and nebulæ seem nearly to evince entire absence of *spherical aberration.* Indeed, the figure must be a *very close* approximation to the *parabolic curve*, if it is not the very curve itself.

Previously to the 23d of July, on account of the state of the atmosphere, Mr. Lyman had been unable to use a power higher than 275. But on that evening the instrument admitted of a power of 550 with perfect clearness of the image, and for an hour or so, would, he believed, have admitted of 800 or 1000. In company with a couple of his neighbors, he examined π Aquilæ, τ and λ Serpentarii, the components distant $1''$ each according to Struve and Maedler. With a power of 550 the separation was perfectly distinct; and one of the gentlemen said, had the distance been but $\frac{1}{2}''$, he believed the separation would have been complete; and there was reason for this opinion, for they examined the last named star with a power of 275, and the separation was clear to them all.

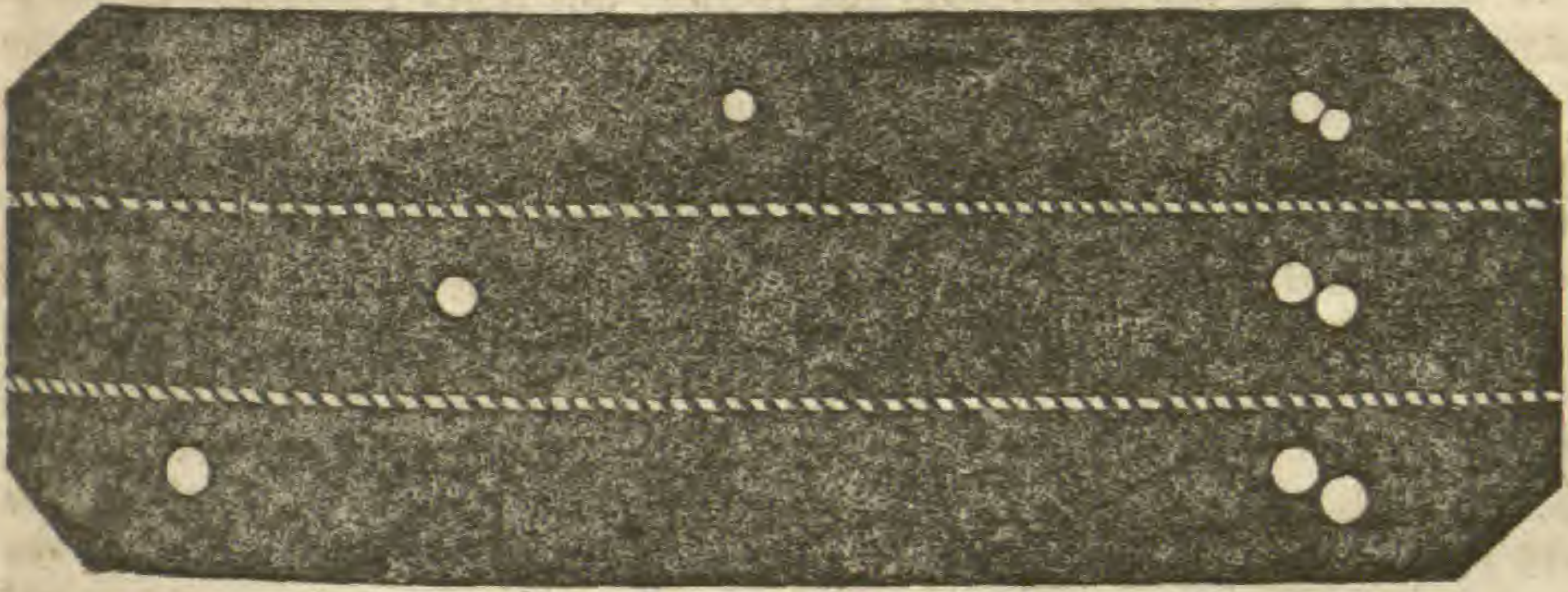
Of an examination of several celestial objects at the Albany Academy (at the conclusion of the late meeting of the "American Association for the Advancement of Science,") at which several gentlemen were present, Mr. S. Alexander, Professor of Mathematics and Astronomy, of the College of New Jersey, speaks as follows:

"I was present at a partial trial of the sixteen feet reflecting telescope made by Mr. Josiah Lyman, on the evening of August 23d. The night was a tolerably favorable one; the amplifying power about 275. The two component stars of π Aquilæ, were satisfactorily separated; the cluster in Hercules presented somewhat of a granular appearance even at the center; and the large nebula in Andromeda showed a variation of light at the center, as though with greater light and power it might have been resolved. I have been accustomed to the use of a refractor; but I could not help regarding the performance of Mr. Lyman's telescope as highly satisfactory.

Albany, Aug. 25, 1851."

On the evenings of August 28th and 29th, at Lenox, Mr. L. tried the instrument on ε Equulei, in company with several individuals, among whom was Dr. Sabin, a physician of that place, and on the latter evening Dr. Skinner and lady, of New York city. The appearance was precisely as represented in the following diagram, which has been shown to all the persons who observed, and approved by them. The description of this star in Kendall's Uranography, published in 1844, and taken from the latest observations of Struve and Maedler, is this. " —— a triple star of the 6th, 6th and 7th magnitudes, whose distances are $\frac{1}{2}''$ and $11''$." Mr. Kendall remarks in respect to τ Serpentarii, that in the 14 feet refractor used by Struve at Dorpat, in 1828, it appeared single.

Appearance of ε Equulei, as seen in the 16 *feet Reflector at Lenox Aug.* 28*th and* 29*th*, 1851.



A, power 275.—B, power 410.—C, power 550.

The relative distances of *the centres* in this diagram are taken from Kendall's description; no micrometers being at hand in this observation. But the distances of the *outlines of the disks of the closer stars* is precisely as the telescope showed them with the specified powers.

In 1835 the stars were seen in contact; the distance was $\frac{2}{5}''$. Of γ Virginis, he says: "In 1836 the components were so close that no telescope in the world would separate them; the distance was $\frac{3}{10}''$." The Dorpat telescope with a power of 1000, (according to Kendall's cut,) showed them overlapping each other nearly $\frac{1}{3}$ the diameter of the smaller stars. The inference is, that the Dorpat *Refractor* was limited in its resolving power to about $\frac{1}{2}''$. And it is equally clear that the *Reflector* made by Mr. L. would resolve stars somewhat *closer* than $\frac{1}{2}''$.

On the evening of Sept. 5th, 36 Andromedæ was easily resolved by five or six gentlemen of Lenox, with a power of 275.

Mr. L. and two other gentlemen examined ε Arietis, on the evening of Oct. 9th. This star is thus described by Kendall.

"ε, in the hinder part of the back; both white; of the 6th magnitude; distant half a second." It was distinctly separated with a power of 410, and with 550 the division was *steady and constant*. They believed this star to be a little more difficult and a little *closer* than ε Equulei. Moreover, inasmuch as it is not even *suspected* of being a *binary system*, and the distance of the components consequently remains unchanged, it was an extremely satisfactory test observation.

V. Miscellaneous Intelligence.

1. *Notes on Vesuvius, and Miscellaneous Observations on Egypt*, (from letters to the Smithsonian Institution, from a traveller in the East; communicated for this Journal.)—*Vesuvius.*—At Naples we had the good fortune to witness an eruption of Vesuvius, and we ascended the cone a day or two before the flow of lava commenced. An American who went up a week earlier found the crater empty, but at our visit it was very nearly filled up with scoria and was emitting smoke from two openings, where the red-hot (but not fluid) matter could be seen, as

well as from numerous smaller crevices. During the eruption I made several visits to the mountain and observed its phenomena as well as I was able with so imperfect means. The ejections consisted of vapor, sulphurous gases, volcanic sand, steam, fragments of lava from the cone, and of several currents of fluid lava. The vapor and the gases were thrown out not only from the crater, but from numerous openings near the summit of the cone, and they also accompanied the currents of lava, both at their source and along their course. The sand was in less quantity than has been often observed, scarcely covering the ground three or four miles from the crater, though in some places it fell in greater abundance. The smoke occasionally settled down so as to conceal the whole cone, which, as you will remember, is about 1500 feet in perpendicular height; but as there was a brisk north wind during almost the whole eruption, the summit of the cone was generally visible. The lava was thrown up from the cone in red-hot and doubtless fluid masses, of such diameter as to be visible to the naked eye at the distance of two or three miles by day, and much farther by night. Of these masses, a large proportion fell back into the crater, which is one-third of a mile or thereabouts in diameter, but vast numbers fell without. These were generally hardened before they struck, but some remained in a semi-fluid, or at least plastic state, which, however, continued but a few seconds. It was very difficult to determine the height to which these fragments were thrown, by observing the time of their fall, because they could not readily be distinguished among the thousands of others which were rising and falling at the same time, as well as for other reasons; but I succeeded in satisfactorily measuring the time of the descent of several of the larger masses. The longest times I observed were seven, eight, and in one instance ten seconds. The explosions by which the fragments were thrown up occurred at pretty regular intervals of eight seconds or thereabouts, but the rise of them was scarcely at any time quite intermitted. Although the guides affirmed the contrary, I do not believe the lava flowed over the edge of the cone at any time. The only currents I was able to discover, burst out at various points, the highest being about one-third above the base of the cone. The difficulty of reaching these mouths was considerable, and I attempted it but twice, approaching on both occasions within fifteen feet of the outlet. The lava was here thrown out in a rapid current, or rather spout, and at short intervals bubbles would burst from the orifice and throw fragments from a few inches to two or three feet square to a considerable distance. I secured one of these which fell at my feet, and imbedded a large copper coin in it while it was yet soft, and brought away also a smaller fragment which struck my leg. After this orifice had ceased to flow, I visited it and estimated it to be twelve feet or more in diameter. While the lava was flowing from it, the velocity of the current at the moment of its escape could not well be estimated, but I succeeded twice, in spite of the suffocating vapor, in approaching quite near the current a hundred yards below, and by watching the motion of the scoria which fell upon it from a bank of hardened lava, and throwing stones upon it (which floated like wood on water) I satisfied myself that it here flowed, though in a much wider stream than at the point where it issued, at the rate of four miles an hour. Though in broad daylight, the color was a bright cherry red, there were no scoria formed on the surface, and the motion was to the eye very like that of a mountain brook swollen by rain.

In the early stages of the eruption it was not accompanied by any loud sound, nor did I hear that an earthquake was observed ; but after the eruption had continued a few days, the roar of the mountain could be distinctly heard at Naples, and at the foot of the cone it was appalling beyond any sound I ever listened to. It was not till the eruption began to abate that any electric phenomena were observed in the cloud of smoke, but from this period flashes and chains of lightning with thunder, easily distinguishable from the roar of the mountain, were frequent. I also visited the lava at two points, distant probably two miles or more from the outlet. It here presented a vast wall ten or fifteen feet in height, composed of red-hot scoria and stones, and was then moving through vineyards of great extent (and with trees of six or eight inches in diameter, as supports to the vines) at the rate of about twenty yards the hour. A quarter of an hour after we left one of these points, a new outburst from the mountain suddenly urged forward the whole mass a distance of two hundred yards, prostrating a church and several cottages and burying the road over which we had just passed. Upon the whole it was the most interesting natural phenomenon I have ever witnessed, and it was with no small regret that I left Naples before the eruption had entirely ceased.

Egypt, &c.—I found the climate of Egypt neither so warm nor so dry as I had expected. We had rain at Cairo twice between the 10th and 20th of January, and at Esneh, in Upper Egypt, we had a rain storm of twenty-four hours' duration. There was another heavy shower, accompanied with thunder and lightning, which extended from Cairo several hundred miles southward, about the middle of April, and we often saw traces of heavy rains in the neighborhood of the river. The form, if one may so speak, of the lightning flashes, in the April storm, was peculiar, resembling the zigzag branches of a tree with spires at every angle. Almost all the *near* discharges appeared of this character, which, however, though new to me, may be a very common one. Among other atmospheric phenomena, I may mention that the *zodiacal light* was distinctly visible *every* night, except when the light of the moon was too great, from January to June, and in all latitudes from 21° 45′ to 31°, and that on one occasion, we saw clearly three of the satellites of Jupiter, with the naked eye, at Cairo. I may add that while on the eastern shore of the Gulf of Suez we observed at 1 P. M., at an altitude of about 50°, and upon the same side of the zenith with the sun, a long, narrow, right lined stratus cloud, exhibiting as distinctly as a rainbow the prismatic colors, the red being uppermost or towards the sun.

From January to May the thermometer on the river stood at about 50° at sunrise, and rose to from 75° to 85°, and once to 93° in the hottest part of the day. From the 10th to the 15th of May, when we were between Suez and Mount Sinai, the mercury rose every day to from 100° to 116° in the shade, but at Mt. Sinai it fell to 54°, with thunder, rain and hail, and, with the exception of a single day at Akaba, the weather was not only cool, but almost cold until July. We were about forty-five days in the desert, and made the entire journey on camels. I was exceedingly interested in the physical geography of Arabia, and with the exception of Northern Syria, which is far richer in fossils, I doubt whether there is anywhere a better field for the study of igneous and metamorphic rocks. The mountain group of the Sinaitic peninsula rises to the height of 8000 feet, and as the whole chain is devoid of vegetation, and completely bare of earth, the rock formations, with their innumerable dykes and other effects of igneous disturbances, are completely exposed to view for very great depths. The wadees, or valleys between the mountain ridges, are filled in winter by violent torrents, and, as all the mountains of the peninsula are in a state of advanced degradation, these torrents bring down into the valleys innumerable specimens of every species of plutonic rocks, and one may gather a fine mineralogical collection without pickaxe or hammer; though, of course, the referring of them to their original locality would be no easy matter, and it is sometimes very difficult to imagine how, with the present configuration of surface, they could ever have been transported by water from their original beds to their present places of deposit.

The particular locality which interested, I might say enchanted, me most, was the head of the Gulf of Akaba (Aclanitic gulf) near the island of Graia. Here the mountains meet the sea, and the camels wade around the promontories. The conditions of rock and water are here eminently favorable to the formation of conglomerates, and you see them in every stage from a mere agglomeration of fragments of granite, syenite, porphyry, basalt, &c., mingled with recent shells and corallines, to that of a silicified and water-worn rock, composed of the same materials. This part of the sea is also filled with marine plants and corallines in great variety, and of striking forms, among which swim the most gorgeously painted fish I ever conceived of. All this, alas! one must see from his camel's back, for Akaba has not a single boat, or even a palm tree raft.

March 14, 1851.

2. *Effects of Lightning;* by Wm. Coffin, Professor of Mathematics at Illinois College, Jacksonville, (communicated for this Journal.)—On the 21st of August, a boy, (son of R. Yates, Esq., our representative to Congress,) was passing home from his next neighbor's and was killed instantly by a stroke of lightning. The two houses were only 250 feet apart, and he was within 50 feet of the one he had just left. It was in a part of the town thickly settled, the boy being in the only vacant lot near. There was a lightning rod on his father's house but none on the one nearest him. There were no trees or high objects of any kind nearer than the houses. The telegraph wire passes about 150 feet from the spot, parallel with the direction in which the boy was going.

The only marks upon the boy were a few small spots on the forehead probably caused by heat and not extending below the cuticle. His eyebrows and front hair were considerably singed. His hat (a common straw hat) had a hole three inches in diameter knocked through the front crown. Most of the straw was carried entirely away, and around the edges of the hole all the straws were pointing upwards. There were no other marks on his body or clothes, nor on the ground where he stood.

The appearances of the storm were as follows. The first part of the day was clear and pleasant; but about one o'clock, clouds were noticed in various parts of the heavens, and there were many indications that we were about to have one of the sudden, severe, but short thunder showers which are of frequent occurrence here. Soon after two o'clock, two clouds were seen to rise rapidly and approach the zenith, one from the north, the other from the southwest. Frequent flashes of lightning were seen from them, showing that both were thunder clouds. Soon after the stroke by which the boy was killed, these two clouds met and passed off together to the southeast, and in a short time the sky was clear again. At the time the boy was killed, the cloud from the north was almost directly over his head.

I have thus simply given the facts of the case. There are several things remarkable about it. It is the first case, so far as I know, of death by lightning in the open air in the midst of a town. The appearances of the hat and the clouds indicate that the boy was killed by a "*return stroke;*" the electricity passing from one cloud to the other and taking the earth and the boy in its circuit. The houses west and south of the spot are well supplied with lightning rods and perhaps the electricity passed silently from the cloud to the earth by these and accumulated at the very spot where the boy was passing. I have been asked repeatedly, "whether the telegraph wire had anything to do with it?" My answer has been that I could see no way in which it could have.

3. *Coating Metals: Henry Grissell's (of the Regent's Canal Iron-works) improvement in coating metals with other metals.* Patent dated January 11th, 1851. Enrolled July 10th, 1851, (London Patent Journal.)—The patentee's improvements in coating metals with other metals are as follows:—

Coating Iron with Zinc.—For this purpose the patentees use a bath or vessel of iron, or other suitable material, in which, by means of heat, they melt the zinc, and on the surface of the melted zinc place a thick layer of chlorid of zinc (prepared by dissolving zinc in muriatic acid, and driving off the water,) or a mixture composed of 8 parts of chlorid of zinc, and 10 parts of chlorid of potassium, or a mixture of equal parts of chlorid of zinc and chlorid of sodium, or chlorid of potassium. When the metal and the salt are in a state of fusion, the iron to be coated with zinc is dipped into the metal, through the covering of fused salt, and becomes coated with zinc. If, however, it is found that a sufficient quantity of zinc has not adhered to the iron a small quantity of sal-ammoniac, in powder, is sprinkled over the iron, which is again dipped into the melted zinc. Under this part of their invention, the patentees claim the use of chlorid of zinc applied as above mentioned in the fused state; also of the mixtures of the various salts above enumerated.

Coating Zinc, Iron coated with Zinc, or other Metal, with a Metallic Alloy.—For this purpose the patentees use a vessel of iron, or other suitable material, in which the alloy is melted. One of the alloys used by them is composed of zinc 10 parts, tin 26 parts, and lead 5 parts. A layer of chlorid of zinc mixed with an equal weight of sal-ammoniac is kept in a state of fusion on the surface of the metal alloy, the temperature of which must not be carried higher than is sufficient to keep the alloy in a fluid state. The metal to be coated is dipped into the melted alloy, but not allowed to remain therein longer than is absolutely necessary to receive a coating of the alloy. The patentees use also the alloy called "fusible metal," which they prefer to make as follows: bismuth 8 parts, lead 5 parts, and tin 3 parts; alloys of other compositions will do, provided that their melting points are below 400 deg. Fah. The patentees claim the use, in the manner above stated, of the alloys specified and referred to, and of the method above described for coating metals with such alloys.

Coating Iron or other Metal with Tin, or Tin alloyed with Lead.—For this purpose the patentees use a vessel of iron, or other suitable material, in which the tin or alloy is melted, and on the surface of the fused metal lay a stratum of chlorid of zinc, mixed with about its own weight of sal-ammoniac. The metal to be coated is then dipped into the liquid metal or alloy, until the coating is effected. The patentees state that it will be found advantageous, in the use of this and the preceding processes, to dip the metal to be coated several times, in order that it may come in contact often with the layer of fused salt; also advantageous in the preceding process to dip the iron or other metal into a hot and slightly acid solution of chlorid of zinc, previous to immersion in the bath of melted metal. The patentees claim, under this head of their invention, the use of a mixture of chlorid of zinc and sal-ammoniac, forming a saline compound, which is kept in a state of fusion on the surface of the melted tin or alloy, in the process of coating metals with other metals.

Coating Iron or other Metal with Silver, or Alloy of Silver and Copper.—In this case, the surface of the iron or other metal to be coated is to be first amalgamated in the usual way. The patentees prefer to use for the amalgamating process, a mixture of 12 parts of mercury, 1 of zinc, 2 of sulphate of iron, 2 of muriatic acid, and 12 of water; the mixture to be heated, and, when 200 deg. Fah., the iron to be amalgamated is placed in the mixture, and the mercury rubbed on the surface of the iron. The silver, or alloy of silver, is then melted in a crucible, placed in a suitable furnace, and the amalgamated metal is dipped into it until it has acquired a proper coating of the silver or alloy employed.

Under this head, the patentees claim the process of coating iron or other metal with silver, or alloy of silver and copper, by amalgamating the surface of the metal to be coated, and then putting it into the melted silver or alloy.

Coating Iron with Copper, Brass, or any Alloy of Copper, with Zinc, Tin, or Lead.—In this case, the copper or alloy used is melted in some suitable vessel, and on the surface of the melted metal is placed a layer of borosilicate of lead, (composed of 112 parts of oxyd of lead, 24 of boracic acid, and 16 of silica,) and when the metal and the salt are in a state of fusion, the metal to be coated is introduced through the layer of salt into the melted metal, where it is allowed to remain long enough to acquire a coating of the metal. The patentees sometimes coat the iron with zinc, or with tin, or even amalgamate its surface with mercury, in the way above mentioned, and then proceed to dip it into the melted copper or alloy. Another method of coating iron with copper or brass, is that of exposing it to the vapor of chlorid of copper, by placing that substance at the bottom of a copper crucible. in the upper part of which is placed the iron to be coated. The crucible is heated to redness, in a suitable furnace, and the vapors of the chlorid of copper volatilize and coat the iron with copper. If the iron thus coated with copper be placed in the upper part of a covered crucible, in which metallic zinc, covered with animal and other charcoal, is placed, and heat applied as in the above case, the vapors of the zinc rise, and, coming in contact with the copper-coated iron, convert the coating of copper into brass. Instead of chlorid of copper, a mixture of metallic copper and sal-ammoniac may be used, or a mixture of oxyd of copper and sal-ammoniac.

The patentees claim, under this head of their invention, the use of borosilicate of lead, in a fluid state, over a surface of melted copper or brass, or of the alloys above mentioned, in the process of coating iron by immersion; also, the process of coating iron with copper by the action of fused chlorid of copper, or the mixtures above named, and of coating with brass by subsequent treatment with vapors of zinc, as above mentioned.

4. *On the Gamboge Tree of Siam;* by Dr. Christison, (Proc. Roy. Soc. Edin., Jan., 1850, p. 263.)—Although gamboge has been known in European commerce for nearly two centuries and a half, and its applications in the arts have been extended in recent times, the tree which produces it is still unknown to botanists.

The late Dr. Graham, in 1836, was the first to describe accurately a species of Garcinia, which inhabits Ceylon, and which is well known there to produce a sort of gamboge, not, however, known in the commerce of Europe. Resting on a peculiarity of the structure of the anthers, which are circumscissile, or open transversely by the separation of a lid on the summit, he constituted a new genus for this plant, and called it *Hebradendron cambogioides.* At the same period the Author examined the properties of this gamboge, and found that it possesses the purgative action of the commercial drug in full intensity, and that the two kinds agree closely also, though not absolutely, in chemical constitution.

At an earlier period Dr. Roxburgh described, in his "Flora Indica," another species of Garcinia, under the name of *Garcinia pictoria*, which inhabits the hills of Western Mysore, and which also was thought to produce a sort of gamboge of inferior quality. In 1847, specimens of the tree and its exudation were obtained near Nuggur on the ghauts of Mysore by Dr. Hugh Cleghorn of the East India Company's service; and the author, on examining the gamboge, found it all but identical with that of Ceylon in physiological action, in properties as a pigment, and in chemical constitution. The same plant, with its gamboge, was about the same time observed by the Rev. F. Mason, near Mergui in Tavoy, one of the ceded Burmese provinces.

A third species, inhabiting the province of Tavoy, and also producing a kind of gamboge, was identified by Dr. Wight in 1840 with Dr. Wallich's *Garcinia elliptica*, from Sylhet, on the northeast frontier of Bengal. Its exudation was long thought to be of low quality. But, although this substance has not yet been examined chemically, it has been stated by Mr. Mason to be, in his opinion, quite undistinguishable as a pigment from Siam gamboge.

It is a matter of doubt whether Graham's character is sufficiently diagnostic to be a good generic distinction. But it was shown by Dr. Wight in 1840, that a well characterized section at least of the genus Garcinia consists of species which have "sessile anthers, flattened above, circumscissile, and one-celled;" and that all these species, and no others, appear to exude a gum-resin differing probably very little from commercial gamboge.

Still the tree which produces Siam gamboge, the finest and only commercial kind, continues unknown. A strong presumption however arose, that the last species was the Siam tree, as it grows in the same latitude with the gamboge district of Siam, and not above 200 miles farther west. But if the information recently communicated to the author be correct, the Siam tree is a fourth distinct species of the same section. In December last he received from Mr. Robert Little, surgeon at Singapore, specimens taken from two trees which were cultivated there by Dr. Almeida, a resident of the colony, and which were obtained by him "direct from Siam" as the gamboge tree of that country. These specimens are not such as to allow of a complete description; yet they are sufficient to shew that the plant presents the characters of Wight's gamboge-bearing section of the genus Garcinia; but that it is not any of the species hitherto so fully described as to admit of comparison with it. The fruit is round, not grooved, crowned by a four-lobed knotty stigma, and surrounded by numerous sessile or subsessile aborted anthers, and by a persistent calyx of four ventricose fleshy sepals. The male flowers consist of a calyx of the same structure, a corolla of four ventricose fleshy petals, and a club-shaped mass of about forty subsessile anthers, closely appressed, connected only at the mere base, one-celled, flattened at the top, and opening by a circular lid along a line of lateral depressions; and there is no appearance of an aborted ovary amidst them. These are the characters of the three species presently known. These three species very closely resemble one another in general appearance and special characters. The new species presents the same close resemblance to them all; and, in particular, its foliage is undistinguishable from that of *Garcinia elliptica*, the leaves being elliptic, acuminate, and leathery, exactly as described and delineated by Wight. But it differs from them all in the male flowers and fruit being peduncled. The male flowers are fascicled, and have a slender peduncle three-tenths of an inch in length. The single young fruit attached to one of the specimens has a thick fleshy peduncle, like an elongated receptacle, half as long as the male peduncle. All the other species hitherto described have both male and female flowers sessile or subsessile. As this difference cannot arise from a mere variation in the same species, the plant must be a new one. The evidence however that it produces gamboge, and more especially the commercial gamboge of Siam, is not yet complete; and, until further information on this point be obtained, which the author expects to receive in the course of the year, it appears advisable not to attach to it a specific name. A question may even arise whether the male flowers and the fruit here described may not belong to two species instead of one; but this is far from probable.

5. *Patent for a Safety Paper granted to W. Stones*, (Chem. Gaz., Oct., 15, 1851, 400.)—The object of this invention is to manufacture a paper that will indicate by discoloration of its surface, when an attempt has been made to extract written characters therefrom; and thereby to afford to bankers, merchants, and others, protection against forgery, or the tampering with cheques, bills of exchange, and other important documents.

The invention consists in the employment of iodine or bromine, together with ferrocyanid or ferricyanid of potassium and starch, either in the manufacture or preparation of Safety Paper. For this purpose, iodine or bromine is used, in any of their ordinary combinations, with bases; but iodine being the cheaper material, is preferred to any compound of bromine. Of the compounds of iodine, the patentee employs in preference that known as iodid of potassium, such substance being the most readily attainable in the market, and in no degree affecting the color of the paper. The mode of applying this substance is by mixing it with the pulp or size, or the paper may be saturated with a solution of the metallic iodid. The ferrocyanid or ferricyanid of potassium is mixed with the size, or it may be applied subsequently to the sizing, as in the case of the metallic iodid. The starch is preferred to be mixed with the pulp in the engine; but it may, like the other chemical ingredients, be used in an after stage of the process.

The proportions for these several materials, used for rendering paper sensitive to the action of reagents, are by no means absolute; but as a guide it may be stated that the following have been found to answer the purpose, viz.: for a ream of post weighing about 18 lbs.—

1 oz. iodid (or bromid) of potassium,
$\frac{1}{4}$ oz. ferrocyanid (or ferricyanid) of potassium,
1 lb. starch.

On the application to paper, prepared as above set forth, of reagents, to dissolve out or absorb any ink-markings therefrom, the tendency will be to break up one of the salts named. Thus, on the application of chlorine or mineral acids, the iodine will be liberated, and, combining with the starch, will form an insoluble iodid of starch of a dark color; and, further, the iron, which ink generally contains, being attempted to be dissolved by either vegetable or mineral acids, the ferrocyanid of potassium will combine with it in solution, and form the well-known prussian-blue compound, which will become diffused over the adjacent portion of the paper.—Sealed Feb. 24, 1851.

6. *On the Manufacture of Candles;* by W. Carpmael, Esq., (Proc. Roy. Soc., Feb. 21, 1851, p. 21.)—Formerly the classes of candles manufactured in this country were wax, spermaceti, and tallow, the materials being used almost in their natural state.

The manufacture of *wax* into candles has received no improvement, but is still a rude process, consisting of hanging a series of wicks (each composed of several yarns of Smyrna cotton slightly twisted together) around a hoop suspended in the air: the workman pours the melted wax on to the wicks in succession till the candles are about one-third made, when they are allowed to cool for a time: then again the process of pouring on the melted wax is repeated, till the workman judges, by sight or by weighing, that the candles are about half made; when they are again allowed to cool and set for a time, after which the candles are rolled on a slab of marble. The upper part of the candle is formed by cutting away the wax down to a metal tag, which covers one end of the wick. The candles are then again suspended to hoops, the end of the wick which had previously hung downwards being now upwards; and the process of pouring on melted wax is again repeated, and the candles finished to the desired size, when they are again submitted to the process of rolling between two smooth surfaces; the lower ends are cut off, and the candles are finished. The bees-wax employed before being thus used is bleached, and is generally mixed with a quantity of spermaceti.

The next class of candles to which attention was called was *spermaceti*, of which material many hundreds of tons are annually brought to this country. This material in the manufacture of candles is mixed with about three per cent. of bees' wax, to prevent the spermaceti crystallizing. Formerly spermaceti candles were inferior to those made of wax, the same class of wick being used. Some years ago, platted wicks were substituted for the twisted wicks before employed: this was a great step to improvement. Platted wicks have a tendency to turn out of the flame while being consumed, the effect of which is to cause the wicks to be burned away, rendering the use of snuffers unnecessary. Since that time spermaceti candles, in place of being considered inferior, are preferred by many to candles made of wax. They are made by pouring the melted material into pewter moulds in which platted wicks are first inserted, and retained securely in the centre of the moulds. Other candles also are made of mixtures of wax and spermaceti, called composition candles.

Mr. Carpmael next called attention to the manufacture of *tallow* candles,—"dips" and "moulds." The former are made, as is generally known, by suspending several wicks a short distance apart, (each consisting of several cotton yarns) on a rod; the wicks are dipped several times into melted tallow; the coats thus taken up are allowed to cool and set. The mould candles are produced by pouring the melted tallow into pewter moulds in which proper wicks (each of several cotton yarns) are first fixed centrally. These wicks require snuffing. A great improvement was some years back introduced into this manufacture by employing cords of cotton as wicks, which are coiled spirally round wires. The wires and the coiled wicks are introduced into moulds, and the wires are withdrawn when the tallow is set. These candles will, however, only burn in lamps, the turning out of the wicks melting the candles down on one side. This improvement introduced a new manufacture of lamps called candle-lamps, which of late years have greatly increased in use; various sizes of candles being now made, some having as many as four wicks, and suitable for large table lamps. This manufacture has been greatly improved by the introduction of several means of making wicks which will turn out of the flame, and yet will admit of being introduced in a straight line within a candle. Attention was called to several descriptions of wicks for this purpose: they all act, however, on one principle, that of having a preponderance of strength on one side, which may be done in a great variety of ways. One of the most simple is the ruling of a line on one side with paste, which gives additional stiffness or strength to that one side, and such wicks in burning turn out of the flames. Following out this principle, the wicks may be modified to suit the various requirements of the different materials employed in candle-making, each of which requires a different character of wick. This was shown by several candles being burned having wicks slightly differing from those which were best for each particular case, proving that great observation and skill is requisite in the manufacturer in order to adjust the material and wick to each other in every case. Attention was also called to the fact, that up to the present time, manufacturers have not been able to employ platted wicks in wax candles or tallow candles.

Ordinarily in making mould candles the wicks are placed by hand into the moulds, and the same are retained fast therein by pegs at one end and by wires at the other. A great improvement has been introduced into this part of the mechanical processes, by causing the candles as they are discharged from the moulds to draw fresh wicks into the moulds; and on the candles being then cut off from the wicks an instrument takes hold simultaneously of all the wicks and retains them correctly in position in the several moulds.

About thirty years ago a celebrated French chemist (Chevreul), when investigating the properties of fatty matters, discovered that they consisted of certain acids; and many efforts were made to introduce one of the acids (stearic acid) into the manufacture of candles, but with little if any practical effect, owing to its highly crystallizing properties. In order to correct this properly, recourse was had to the use of arsenic, which was found to break up the crystals; and candles were extensively made and consumed, rivalling spermaceti in appearance, whilst they were sold at a much less price. But public attention having been called to the injurious effects produced by the vapors of arsenic thrown off by such candles, this greatly increasing manufacture met with a severe check; and if the manufacturer had not discovered a means of employing stearic acid without arsenic in the manufacture of candles the public would probably have ceased to purchase them. This probably is one of the most interesting events in the history of the manufacture. On investigation it was discovered that the cause of the crystalline character found to prevail in stearic acid candles is consequent on the pouring very hot melted stearic acid into cold moulds; and it was found that by pouring the matter when nearly set into moulds warmed to about the same temperature as the candle-stuff, and by using a small quantity of wax, candles of stearic acid can be made possessing very excellent properties. Hence this class of candles has of late years very largely prevailed, which, being made with suitable platted wicks, like spermaceti candles, do not require to be snuffed.

Another class of candles which came largely into use about the same time was produced from the stearine of cocoa-nut oil; but this candle required snuffing. A great step of improvement in the manufacture of candles resulted from combining these two matters, viz., stearic acid of tallow with stearine of the cocoa-nut. It is found that stearic acid of tallow burns with a somewhat red flame and is liable to smoke; it contains too large a quantity of carbon: whilst the stearine of cocoa-nut oil contains too much hydrogen, and burns with a white flame. The effect of combining these two matters was to obtain a better flame than either, when used separately. The product is cheaper, and will also admit of the use of platted wicks; and the tendency of the stearic acid to crystallize is corrected by the employment of the stearine of the cocoa-nut. These candles are known by the name of "composite," and have been sold in immense quantities.

Mr. Carpmael next called attention to the modern introduction of palm-oil in the manufacture of candles, the properties of which are peculiarly suited to candle-making. The *stearine* of it, even in its crude state makes excellent "dip" candles when the quality of the light only is considered; but they are of a bad color. The palm stearine also makes good lamp-candles; but the great use of palm-oil as a candle-stuff is when distilled for this purpose. The crude oil is first treated with acid to bring it into an acid state, and the same is then distilled by means of steam, which in its passage from the boiler passes through a series of pipes heated by a furnace, by which the steam becomes very highly heated (600° Fah.) and in that state it enters into the still, and amongst and below the chemically prepared palm-oil, which is thereby caused to distil over, and is condensed in suitable apparatus; the product is pressed: and by these means a most beautiful material closely resembling spermaceti is obtained, and from which those modern manufuctures of candles now so largely and so well known as Belmont sperm and Belmont wax are produced.

The table was largely supplied with candles of every description of manufacture, by which the peculiarities of each class could be readily pointed out, and examined.

7. *On the Meteoric mass discovered at Schwetz;* by M. G. Rose. (Berlin Acad., Feb., 1851; L'Institut, No. 912, June, 1851.)—In the spring of 1850, while removing a hill of sand, in the grading of a railway, near Schwetz on the Vistula, a mass of iron, about 4 lbs. in weight, was found at a depth of 4 feet, at the limit where the upper sand covers the subjacent clay. The mass sent to Prof. Rose is somewhat prismatic in shape, about 9 inches (Prussian) long, with the thickness $5\frac{1}{2}$ and 4 inches, a line around it lengthwise being 24 inches long, and transversely $17\frac{1}{2}$ inches. The whole mass weighs about 43 lbs. (livres). There is a fissure cutting it somewhat diagonally. The outer surface is rounded and covered with hydrated oxyd of iron, and so also that of the fissure. A surface cut and polished and acted upon by an acid, exhibted fine Widmannstattian figures, much like those of the Texas iron. There is a mixture of some large and small grains of sulphuret of iron. M. H. Rose has detected in it nickel. It is in the hands of Rammelsberg for a complete analysis.

8. *Xenotime from the Gold region of Georgia.*—Prof. Lewis R. Gibbes in a letter to one of the editors dated Charleston, Nov. 21, states that about two years since he obtained in an excursion to the

mountains of Georgia a quantity of the refuse from the washings of a "pocket mine" of gold near Clarksville, Georgia, among which were small octahedral crystals affording, by the reflective goniometer, for the angle of the pyramid, 124° 45′, and for that over a basal edge, 81° 40′, which are the angles of xenotime. H=4·0. B.B. with borax and salt of phosphorus slowly dissolves to a colorless glass, and with soda effervesces readily and forms a cream-colored slag. The associated minerals in the "refuse" are zircon, rutile, kyanite, specular iron, garnet, and quartz. The mineral has been tested chemically for phosphoric acid by Mr. Craw of the Yale Laboratory, in accordance with a request from Prof. Gibbes, and an abundant precipitate of this ingredient was obtained.

9. *Xenotime in the Gold region of North Carolina.*—Prof. C. U. Shepard in a letter dated Dec. 1, states that he has detected crystals of xenotime among the sands of the gold washings of McDowal Co., N. C.

10. *Daguerrotypes.*—M. Aubrée has obtained daguerreotypes in thirty seconds with electric light. In two trials he used fluorid of bromine diluted with water. He also employed chlorobromid of lime, but with less success.

11. *Vegetable Parasites in Sugar.*—M. Payen has observed in sugar at Paris a parasitic vegetation which runs in cavities in lines, and changes the sugar to a reddish tint. The sporules of this cryptogamic vegetation were not over one to two thousandths of a millimeter in length. During the present year he detected in a refinery at Paris a variety of this vegetation without a reddish tint, occupying irregularly scattered cavities; its sporules are a little larger than in the reddish kind. The sides of the cavities are covered by a thin membrane from which the filaments proceed. This vegetation he refers to the Mucedineæ and has named it Glycyphila from the Greek *γλυκυς*, *sweet*, and *φιλος*, *lover*.

12. *Climate of Nischne Tagilsk, Urals*, (L'Institut, No. 921.)—M. Demidoff states the minimum temperature for *January* 1851 at $-45\frac{1}{2}$ F., and the maximum at $+27\frac{1}{2}$ F., on the sixteenth of the month at 4 P. M. The meam temperature of the month was $+4\frac{1}{4}$ F. Snowed 29 times.

The minimum for *February* was $-20°$ F.; the maximum $+25\frac{1}{4}$ F. at 3 P. M. on the 15th; the mean $+5\frac{3}{4}$ F. Snowed 19 times.

The minimum for *March* $-25\frac{1}{2}$ F.; the maximum $+42$ F., on the 29th at 3 P. M.; the mean $+16\frac{1}{2}$ F. Days of snow 27.

13. *Theory of Storms.*—Letters have been addressed by Lord Palmerston—as well as from the British Colonial office—to the various British Consuls requesting their co-operation in the collection of data towards a theory of storms, a plan urged by Col. Reid.—*Athenæum, No.* 1248, *Sept.* 27, 1851.

14. *On the Resuscitation of Frozen Fish;* by Prof. S. P. Lathrop, (from a letter to one of the editors.)—It is a fact well known to those who are accustomed to take fish—such as the common perch—*Perca serrato-granulata*, Cuv.; the lake mullet—*Catostomus oblongus*, Mitchell—from Lake Champlain in the winter, that these fish may be frozen perfectly solid and be transported many miles and kept several days, (and I do not know but an indefinite time,) when upon thawing them

out in a tub of cold water, they will be found to be alive and active. I once took some pains to corroborate this fact by inquiry, and found it to be well sustained by evidence though my eyes have not seen it. I find the same fact sustained in the case of the buffalo fish taken from the Rock river at this place.

15. *Cavendish Society.*—The Cavendish Society, is a voluntary association for the publication of such works or memoirs on Chemistry as otherwise would not be found in the English language. Their publications hitherto have been of an exceedingly valuable character. The chemistry of Gmelin, a work of vast learning in German, and by far the best treatise on the science, is now being issued in English by this Society, five volumes being completed; and various memoirs of French, German and Italian chemists are contained in their other volumes. The Society solicits subscriptions and we would direct attention to their announcement on our advertising sheet.

16. *University of Mississippi.*—OSCAR M. LIEBER, son of Dr. FRANCIS LIEBER of the University of South Carolina, was in July last elected Adjunct Professor of Geology in the University of Mississippi, to assist Professor Millington in the geological survey of that State, which survey is already commenced. J. M.

17. *William and Mary College, Va.*—GEORGE P. SCARBURY of Accomac, one of the judges of the Circuit court in Virginia, has been elected to the Law chair in William and Mary College, vacated by the death of the late Judge BEVERLY N. TUCKER. J. M.

OBITUARY.

RICHARD COWLING TAYLOR died on Sunday morning, the 26th of Oct., at his residence in Philadelphia, in his 62d year, after a very short illness.

The following are extracts from a notice of Mr. Taylor by Mr. Isaac Lea, published in the Proceedings of the Acad. Nat. Sci. Philad., for October, 1851.

"The first work of importance which he published, was one on the Monastic remains of the county in which his father lived as a country gentleman, and on whose property there was a noted Anglo-Norman ruin. It was this probably that induced Mr. Taylor first to turn his attention to this branch of knowledge, and the result was the 'Index Monasticus, in the ancient kingdom of East Anglia,' published in 1821, in 1 vol. folio,* which at once gave him a reputation for thorough investigation and exactness, which noted all his after works, and which has rarely been excelled. This work was received with so much favor, that Mr. Taylor was induced, at the request of the publishers, to undertake that thorough and learned work which he called a 'General Index to Dougdale's Monasticon Anglicanum,' in 1 vol. folio, with plates and maps, which was published in 1830. This took Mr. Taylor two years to complete, and was said to be so perfect as to require nothing further to be added in regard to it. In his profession, he had the great advantage of a most thorough and complete education, and he was

* At a public sale his private copy, with some notes, brought £30.

associated in business with the late Wm. Smith, who has been considered 'the father of British Geology.' * * *

He was soon called into active employment, and we find him engaged, for a time, in the important Ordnance survey of England; and he was also employed by the 'British Iron Company,' whose extensive and valuable property in South Wales, he investigated and reported upon. That portion of the Ordnance Survey which he executed, was finished in a masterly manner, and his drafts were of the most exact and perfect kind. His report on the topography and geology of the mineral lands of the British Iron Company, were so admirably executed, that the Geological Society of London published the map and descriptive parts in its Transactions. In connection with this, he executed a model in plaster of that part of Wales,* which received so much approbation, that the Society of Arts awarded him their *gold Isis Medal*, which is now in possession of his family. Subsequently to this, he was engaged for some years, in England, in the examination of various mining properties, after which he was induced to accept an appointment by Hardman Phillips, Esq., an intimate friend of the family, to remove to this country, and reside in Phillipsburg, Pennsylvania, where he remained four years, under the expectation of the professional employment promised him there. This was an unfortunate movement for himself and family, which now consisted of a wife and four daughters. Having lost, in this residence, both time and money, he removed to Philadelphia, for the purpose of seeking that employment in his profession, in which he was so well qualified to excel. Previous to this, however, he was engaged in the survey of the Blossburgh District, and the line of railroad, which he completed, and on which he made an extensive and able report in 1832.

* * * Shortly after this, Mr. Lea had it in his power to have Mr. Taylor placed in charge of the exploration of the extensive coal and iron property of the Dauphin and Susquehanna Coal Co., in Dauphin county, Pa., in which Mr. Lea had a large interest. Here Mr. Taylor remained about three years, and developed the mineral resources of this extensive mineral district, to the entire satisfaction of the Board of Directors. The whole of the lands embraced 42,000 acres, in a rugged, mountainous district, and required an experience and perseverance which few men had more of than Mr. Taylor. The result of this great labor was an elaborate report, of 187 pages in 8vo, together with about 150 maps, drafts, surveys and sections, which are invaluable to the Company, and in whose possession they now are. In connection with this, during a period of cessation of activity in such works in this country, he employed himself in the execution of a model of this part of the coal basin and its surrounding mountains, which occupied him many months. This subsequently became the property of the Dauphin Company. It embraces in length about 45 miles, and in breadth 15 miles of the district it represents, and is about 14 feet long. It is a complete geological and topographical representation of this important

* This was the first model of the kind executed in England.

district, and alone would be a monument to a man of science, if he had never executed any other labor."

The biographical notice goes on to mention his labors in various surveys, including that of the copper mines of Cuba, and then speaks of his very valuable work on the "Statistics of Coal," mentioned in this Journal, vol. vi, p. 150—a monument of vast industry, learning and judgment.

"Besides the proficiency which Mr. Taylor had acquired in economic geology, he had devoted himself much to theoretic geology, and his knowledge of the various formations, which make the sum of the geological series, was rarely excelled by his colleagues. He had devoted himself more particularly to the strata connected with the coal formation, and he was the first person, as Prof. Silliman stated to a meeting of the American Association of Geologists, who had referred the Old Red Sandstone, underlying the coal of this state, to its true position, corresponding with its place in the series of European rocks. * *

In the year 1832 he was elected a member of this Academy,* and in 1846 a life membership was conferred upon him, 'as a mark of respect and a just appreciation of its means of usefulness derived from him.' * * *

At the time of his death, Mr. Taylor was engaged in preparing a paper for the Journal of the Academy, on the fossil plants which he had discovered in his recent visit to New Brunswick. The fossil fishes which he had discovered there, he left with his friend, Prof. Agassiz, who was to describe the new ones for him. All these Mr. Taylor intended should be deposited in the collection of this Academy, to which he had already added many valuable specimens.

Mr. Taylor was the third son of Samuel Taylor, of New Buckenham, in Norfolk, England, and a descendant of Dr. John Taylor, the author of the Hebrew Concordance. He was born at Banham, in Norfolk, January 18th, 1789. His brothers and cousins were men generally remarkable for their great literary and scientific acquirements. His younger brother, Edgar Taylor, was a distinguished member of the legal profession in London, and an accomplished scholar. He was the author of several works, and remarkable for his numerous learned reviews, published in the most prominent periodicals in Great Britain. His cousin, Richard Taylor, is the well-known and able editor of the Philosophical Magazine, which has been the leading scientific Journal of England for the last twenty-five years. John and Phillip were equally distinguished as mining engineers.

The great services Mr. Taylor had rendered science, have been acknowledged, by his being made a member of the principal Societies in England and this country that embrace those branches of knowledge which he cultivated. He was elected a member of the Geological Society of London, and of the Society of Civil Engineers, of that place. In this country he was a member of this Academy, as before mentioned; of the American Philosophical Society; of the Geological Society of Pennsylvania; of the American Association of Geologists and Naturalists, of the Franklin Institute, &c. &c."

* Academy of Natural Sciences, Philadelphia.

List of Mr. Taylor's Memoirs, exclusive of his Professional Reports.

"Map of the Ordnance Survey," 1813–14, (probably the first.)

In the Trans. Geol. Soc. of London:—"Notices of two Models and Sections of about eleven square miles, forming a part of the Mineral Basin of South Wales, in the vicinity of Pontypool," (1830.) "On the Crag Strata at Bramerton, near Norwich," (1823). "On the Alluvial Strata, and on the Chalk of Norfolk and Suffolk, and on the Fossils by which they are accompanied," (1823).

In the Magazine of Natural History:—In 1829, on the "Progress of Geology;" in 1830, "Introduction to Geology," and "Illustrations of Antediluvian Zoology and Botany."

In the Transactions of the Geological Soc. of Pennsylvania:—"On the Geological position of certain beds, which contain numerous Fossil Marine Plants of the family Fucoides, near Lewistown, Mifflin county, Pa.," (1834). "On the relative position of the Transition and Secondary Coal Formations in Pennsylvania, and description of some transition or Bituminous, Anthracite, and Iron ore beds, near Broad Top Mountain, in Bedford county, and of a coal vein in Perry county, Pennsylvania, with sections." "Notices of the evidences of the existence of an ancient Lake, which appears to have formerly filled the Limestone Valley of Kishacoquillas, in Mifflin Co., Penn." "On the Mineral Basin or Coal Field of Blossburg, on the Tioga River, Tioga county, Penn." "Memoir of a section passing through the Bituminous Coal Field near Richmond, in Virginia." "Review of the Geological phenomena and the deductions derivable therefrom, in 250 miles of sections, in parts of Virginia and Maryland. Also, notice of certain Fossil Acotyledonous Plants in the secondary strata of Fredericksburg," Virginia.

In the Transactions of the American Philosophical Society:—"Memoir of the Character and Prospects of the Copper Region of Gibara, and a Sketch of the Geology of the N. E. part of the Island of Cuba." "Notice of Fossil Arborescent Ferns of the family Sigillaria and other Coal Plants, exhibited in the Roof and Floor of a Coal Seam in Dauphin county, Penn." "Notice of a Vein of Bituminous Coal recently explored in the vicinity of Havana, in the Island of Cuba." (This was conjointly with Mr. Clemson).

In Silliman's Journal:—"Notes respecting certain Indian Mounds and Earthworks in the form of Animal Effigies, chiefly in the Wisconsin Territory, U. S., with Plans and Illustrations." "Notice of a Model of the Western portion of the Schuylkill, or Southern Coal Field of Pennsylvania, in illustration of an Address to the Association of American Geologists, on the most appropriate modes for representing Geological Phenomena," (with illustrative sections).

In the Journal and Proceedings of the Acad. Nat. Sciences:—"Table constructed from a few Meteorological Notes, chiefly in regard to the daily temperature of noon, on the East Coast of the Isthmus of Panama, Port Royal, in Jamaica, and on the return voyage to New York, for the month of October, 1849." "Substance of Notes made during a Geological Reconnoissance in the Auriferous Porphyry region next the Carribean Sea, in the Province of Veraguas and Isthmus of Panama," 1851, with maps. At the time of his sudden illness he was engaged on a paper entitled, "On a Vein of Asphaltum of Hillsborough, in Albert county, Province of New Brunswick," which he has left in an unfinished state, but which is so far complete as to justify its publication in the Journal of the Academy.

VI. Bibliography.

1. *Elements of Analytical Geometry;* by Albert E. Church, A.M., Professor of Mathematics U. S. Military Academy. New York: Geo. P. Putnam, 155 Broadway, 1851, pp. 297.—Among the numerous popular fallacies is the notion that mathematics are *dry*. Any study will of course be dry when not understood. Thus, nothing is less interesting than poetry to a wholly unpoetic mind. Now, if any person finds mathematics dry, he may be sure he does not understand them. In this field, to reap where we have not sown is quite impossible. Nor can the wit of man ever lay a rail through it, to enable one, by sitting still, to go ahead.

So much apropos to a few remarks on Analytical Geometry, a branch of mathematics uniting the graces of geometry to the power and subtlety of analysis. Descartes was a truly great man. If he was too much addicted to foraging on the apples of his neighbors, his intellectual orchard bore enough of the best fruit to pay ample reprisals. The finest product of Descartes's mind was analytical geometry, which, in all its great principles, was essentially his work. Developed and perfected as it now is, the whole range of mathematics furnishes nothing more attractive or intrinsically beautiful. While elementary geometry says unimportant "things in such a solemn way" that we grow seemingly wise quite too soon, calculus treats "the ghosts of departed quantities" with a kind of transcendental sleight-of-hand, which, as Carlyle says, "grinds out the true product, under cover, without other effort on our part than steady turning of the handle." The one is too evident, the other too difficult and mysterious. Descriptive geometry also has much of beauty, but is meager in principles and tediously operose in its methods. Being so recent in its origin that Monge, the illustrious founder of the Polytechnic school, gave it shape and system, there is doubtless very much remaining to be done ere its capacities are fully developed. When it is mature, and the text-books made less clumsy, it will be the natural and fitting vestibule of analytical geometry. The clear geometrical conceptions which it would then give should precede the analysis of lines and surfaces. Without this preparation there is danger of analytical geometry degenerating into mere algebra, and thus becoming nearly barren of interest and value. No person is fit to discuss the general equation of the second degree between two variables who does not keep the geometry of the analysis clearly in mind. It is a fault of most of our analytical researches that their geometrical interpretation is too much left out of sight, so that they stand as lifeless abstractions to men whose abstracting and concreting powers fall below those of Laplace, Poisson, or Cauchy.

Analytical geometry is that branch of mathematics in which lines and surfaces are discussed by the aid of algebraic symbols. In treating plane curves two axes are assumed, and the coördinates of any point of the plane are the lines from the point to the axes, drawn parallel to the axes. The length of these coördinates for the different points of a curve are called variables, and are represented by x and y. The relation between these variables for any plane curve is expressed by an equation. In other words, the coördinates of all the points of any particular curve, as a circle, a parabola, or a cycloid, bear a constant and particular relation to each other, which relation would be a proposition in common language, but in analysis is an equation. By discussing this equation, all the properties of a particular curve may be determined in a rigorous and beautiful manner, singularly in contrast with the verboseness and indirectness of pure geometry. By using three axes and coördinates, curves of double curvature like the helix, and all geometrical surfaces like the sphere, the ellipsoid or the helicoid, can be discussed. The method is absolutely general for all lines and surfaces of a regular geometrical character, though it is not customary in elementary treatises to introduce those whose equations involve logarithms, sines, tangents, &c. The curves of conic sections, and the surfaces generated by revolving conic sections around their axes, form the staple of these treatises. The reason of this is that any other curve or surface must give an equation above the second degree, or one containing transcendental functions, either of which makes too knotty a subject for common students, and needs the skeleton keys of calculus. Any one on comparing the facility, certainty, and conciseness of analytical geometry with the wordy, ungeneralized, and fortuitous methods of the old-fashioned conic sections, will surely bless Descartes, and pronounce this a case of stage coach versus railroad. The English have reason to know this; for their adhesion to the geometric method, under the spell of Newton's guidance, kept them long sadly in the dark, until, by a return to better reason, they were again able to read the works of their French and German neighbors.

In fine, we would say that any young man who wishes to train his logical faculties, and to acquire the most serviceable auxiliary for physical research, should venture even a little midnight oil to master analytical geometry. Elementary geometry, algebra, and plane trigonometry, somewhat thoroughly studied, will, with assiduity, resolution, and faculty, enable him to proceed without difficulty through Davies, Church, or Biot. For a beginner, the best of these will quite surely be Prof. Church's recent work. If he has not made the best English text-book on this subject, he has not done his duty. The clearness and appropriate character of his instruction to fourteen successive classes at the U. S. Military Academy, show that it was his duty to improve on his predecessors. We think he has done so to such an extent as much to facilitate the study of this subject. The reasons given in the preface justify placing the parabola before the ellipse and hyperbola, though strictly speaking it should come between. The parade of enunciation is wisely dispensed with, and timely intelligence is given that the conic sections are cut from a cone. It is a sad inversion to leave this as a parting word when we are bidding good-bye to our crooked friends. As it would be convenient to have all the principal equations and expressions of analytical geometry collected, we venture the suggestion that in a new edition, which must soon be required, such a collection be supplied. So, bidding adieu to Descartes, Biot, Davies, and Church, we retire; not, though, without expressing a hope that too-boastful America may in due time produce something above a text-book in mathematics, as well as a more numerous bevy of those who could understand it when produced. E. B. H.

2. *Maury's Wind and Current Chart.*—This large Chart, measuring 6 feet by 8 in its surface, includes a map of the Atlantic Ocean between 66° north and the equator, nearly the whole of which area is thickly dotted down with figures indicating the temperature of the ocean, and crossed by lines indicating the course of isothermal bands over its surface for the different months of the year. By using to some extent different colors for the figures and lines, the chart is relieved of complexity naturally consequent upon so many and involved markings. The author has brought out these results of his arduous labors with great beauty. The subject he has under investigation is one of the most important in the Physics of the world, and is rendered peculiarly

so by the intermingling of the Gulf Stream and Polar currents in this ocean. Navigation also, as well as science will greatly profit from these investigations, and already both departments have derived much that is new and important. Science looks forward to still more striking developments, as the subject is further studied; for Lieut. Maury, notwithstanding the number of facts already elicited, looks upon his labors as far from completed. We wish him the continued aid and encouragement of government, feeling assured that expense is gain in such investigations.

3. *Shells of New England:* a revision of the Synonymy of the Testaceous Mollusks of New England, with notes on their structure and their Geographical and Bathymetrical distribution, with figures of new species; by WM. STIMPSON. 58 pp., 8vo. With 2 plates. Boston, 1851. Phillips, Sampson & Co.—The rapid progress of Malacology within the few years past, has made numerous changes in its synonymy, changes not to be learned from any common text-book, besides showing that some supposed new species have earlier names: and the work of Mr. Stimpson will therefore be found valuable in representing the existing state of the science, especially as regards New England species. It has additional value from the notes and observations of the author on many species, his suggestions in classification, and his descriptions and figures of new species.

4. *A. P. de Candolle, sa Vie et ses Trauvaux;* par A. DE LA RIVE. 312 pp., 18mo. Paris and Genève, 1851. Joël Cherbuliez.—Prof. De la Rive, the author of this Life of De Candolle, was intimately acquainted with the illustrious botanist, and entered upon his task, as he states, from his affection and respect for him. Himself a philosopher of high merit, he could well appreciate the mind and character of the philosopher whom he would commemorate. The work commences with a chapter on the earlier years of his life; and then takes up his residence from 1798 to 1808 at Paris, from 1808 to 1816 at Montpellier, and from 1816 to 1841 at Geneva. The volume closes with a catalogue of the works and memoirs of De Candolle.

5. *Iconographic Encyclopedia.* New York, 1851. R. Garrigue.—This work, which is calculated to do much for the dissemination of knowledge, speaking as it does by full illustrations as well as by description, has reached its close. It constitutes in all four thick volumes of text, in 8vo, and is accompanied with 500 4to steel plates, containing upwards of 12,000 engravings.

J. C. TRAUTWINE, Civil Engineer: A new Method of Calculating the Cubic Contents of Excavations and Embankments, by the aid of Diagrams. 34 pp. 8vo. Philadelphia, 1851.—A work of great importance to Engineers, it giving a method of obtaining the cubic contents of excavations and embankments, by diagrams, instead of the more tedious one in use by calculation.

ARMY METEOROLOGICAL REGISTER from 1831 to 1842 inclusive, compiled from Observations made by the officers of the Medical department of the Army at the Military Posts of the United States. Prepared under the direction of Brevet Brig. General Thomas Lawson, Surgeon General U. S. Army. *Washington*, 1851.—As several of the various stations where the observations here published were made, are scattered over regions about which little is known in a meteorological way, this work is one of special interest.

R. G. LATHAM: Ethnology of the British Colonies and Dependencies. *London*, 1851.

WM. FERGUSON: Description of the Palmyra Palm of Ceylon; pamphlet, 8vo. *Colombo*, 1850.

C. T. Beke: An Enquiry into M. Antoine Abbadie's Journey to Kaffa, to discover the sources of the Nile. 56 pp. 8vo, with a map. *London*, 1850.

John Gould, F.R.S., etc: A Century of Birds from the Himalaya Mountains. 1 vol. imperial folio, containing 80 plates, with descriptive letter-press. Price £14 14*s.* *London*, 1832. "Only eight copies remain."

—— The Birds of Europe. 5 vols. imperial folio, comprising 449 plates, with descriptive letter-press, Introduction, &c. Price £76 8*s.* *London*, 1837.—The whole of the perfected copies of this work have been sold; with respect to the few that exist in an imperfect state, from the death of the original subscribers or from other causes, the author is willing to enter into arrangements with their present possessors to render them complete; or if preferred, he will give in exchange for them any of his smaller perfected publications corresponding in value.

—— A Monograph of the Ramphastidæ or Family of Toucans. 1 vol. imperial folio, containing thirty-three plates, with descriptive letter-press, &c. Price £7. *London*, 1834.—The extensive researches which have of late years been made in the great Andean Range of mountains in South America, have led to the discovery of many additional species of this group of birds, consequently a revision of the work becomes necessary; figures and descriptions of these new species will be published in the author's "Icones Avium," but will be supplied separately if required, to the subscribers to the original Monograph of the Family.

—— A Monograph of the Trogonidæ, or Family of Trogons. 1 vol. imperial folio, containing thirty-six plates with descriptive letter-press. Price £8. *London*, 1838.

—— Birds of Australia. 7 volumes, imperial folio, containing figures of 600 species, with descriptive letter-press and a large amount of introductory matter. Price £115. London, 1848.—Only 250 copies have been printed, and the drawings have been effaced from the stones.

—— A Monograph of the Odontophorinæ, or Partridges of America. 1 vol. imperial folio, containing thirty-two plates, with descriptive letter-press. Price £8 8*s.* *London*, 1850.

—— The Birds of Asia.—"The Birds of Asia" will not exceed the extent of "The Birds of Australia," and perhaps not that of "The Birds of Europe." Of this work three Parts are published, and for the present it will appear at the rate of not more than two parts a year.

—— A Monograph of the Trochilidæ or Humming-Birds.—The work will be published in Parts in imperial folio, each containing sixteen plates with descriptive letter-press, price £3 3*s.* each part, and will appear at the rate of one or not more than two parts per annum. The First Part is ready for delivery, and the second is in preparation.

—— Icones Avium, or Figures and Descriptions of new and interesting species of Birds from various parts of the World, forming a Supplement to the author's other works. The object of this work is explained in the title: it will be issued as novelties of interest occur, in imperial folio parts containing ten species, with descriptive letter-press; price £1 15*s.* each. Two parts are published.

—— A Synopsis of the Birds of Australia, in imperial 8vo parts, each containing eighteen plates, with descriptive letter-press, price £1 5*s.* Four parts published.—In this work the heads only of the various species are figured.

—— The Mammals of Australia.—The author's visit to Australia having enabled him to procure much valuable information respecting the habits and economy, and many new species, of the singular and interesting Mammalia of that country, he has determined upon publishing a work on the subject, precisely similar in execution to the "Birds," the work to be completed in ten or twelve parts, each containing fifteen plates, price £3 3*s.* Of this work two parts have been published, and have been so highly approved of, that by many they are regarded as if possible even more interesting than the "Birds." The third part is now in the press.

—— A Monograph of the Macropodidæ, or Family of Kangaroos. In three parts, each containing fifteen plates, with descriptive letter-press, price £3 3*s.* each. Two parts published.

Gustav Leonhard: Die Quarz-führenden Porphyre. 212 pp. 8vo, with 2 lithographic plates, 5 colored sections and 12 wood-cuts. *Stuttgart*, 1851. J. B. Müller. An elaborate work, full in its details.

B. Studer: Géologie de la Suisse; vol. 1, 8vo. *Berne* and *Zurich*, 1851.

Liebig and Kopp: Jahresbericht über die Fortschritte der reinen, pharmaceutischen und technischen Chemie, Physik, Mineralogie und Geologie, for 1850, 2nd part. *Giessen*, 1851.

R. T. MAITLAND: Fauna Belgii Septentrionalis. Pars. I, Animalia Radiata et Annulata. 1 vol. 8vo. Lugduni Batavorum, 1851. 8 *fr.*

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PROC. ACAD. NAT. SCI., PHILADELPHIA, Vol. v, No. 11,—SEPT., 1851.—p. 261. A new species of Plumatella (P. diffusa); *J. Leidy.*—p. 262. The American Gordius named *G. varius,* being shown to be distinct from G. aquaticus, L.; *J. Leidy.*—p. 264. Observations on tertiary fossils of San Diego, California; *Dr. Le Conte.*—p. 265. A new Cristatella (C. magnifica); *J. Leidy.*—267. Conspectus of Crustacea of the Exploring Expedition under Capt. Wilkes, tribe Paguridea; *J. D. Dana.**—p. 272. A new American Cicada, from near Philadelphia (C. Cassinii); *J. C. Fisher.*—p. 273. Note on the new species of Cicada, and on the C. septendecim; *J. Cassin.*—OCT. —p. 275. A new Gordius (G. robustus) from the body of a Grasshopper, and a new Mermis from Brazil (M. ferruginea); *J. Leidy.*—p. 276. Note on a mammal cranium (Oreodon robustum, Leidy); *J. Leidy.*—p. 277. A new Acostæa (A. guaduasana), a fresh water mollusc, order Dimyaria, from the river Guadua, New Grenada; *Mr. Lea.* —p. 278. Note on a new fossil mammal, named Arctodon; *J. Leidy.*—A new Spongilla (S. fragilis); *J. Leidy.*—p. 279. Historical sketch of Gordiaceæ; *C. Girard.*—p. 284. Corrections and additions to former papers on Helminthology, published in the Proceedings of the Academy; *J. Leidy.*—*Appendix.* Catalogue of Caprimulgidæ in the Collection of the Academy; *J. Cassin.* This number of the Proceedings contains two colored plates, pl. 7, *Galbula cyanicolis,* Cassin, pl. 8, *Bucco Ordii,* Cassin, illustrating p. 154 of the volume.

PROC. BOST. SOC. NAT. HISTORY, 1851.—p. 65. Facts on the development of Distomata; *J. Wyman.*—p. 66. Note on Holothurias of Massachusetts shore; *Mr. Stimpson.*—p. 67. A new species of Pisidium, (P. ventricosum); *Mr. Whittemore.*—p. 69. A new Holothuria (Thyonidium glabrum), from George's Bank; *Mr. Ayres.*—p. 71. Notes on the seventeen year locust; *Dr. Burnett.*—p. 73. Remarks on the Fossils of Hillsborough, New Brunswick; *Dr. C. T. Jackson.*—p. 78. Observations on vegetation in coal; *J. E. Teschemacher.*

BULLETIN DE LA SOC. IMP. DES NATURALISTES DE MOSCOU. 1849, No. 4, and 1850, Nos. 1 and 2, have been received by us.

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* See page 121, of this volume.

THE

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[SECOND SERIES.]

Art. XII.—*Extracts from a Memoir of Samuel George Morton, M.D., late President of the Academy of Natural Sciences of Philadelphia;* by Charles D. Meigs, M.D.*

* * * * Samuel George Morton was born at Philadelphia, on the 26th January, 1799. His father, Mr. George Morton, a native of Clonmel, in Ireland, was descended from a respectable stock in that city, and was trained in early life amidst a family, in which the gifts of education were highly prized and abundantly enjoyed. For the purpose of augmenting his fortune, he early emigrated to America, and devoted himself to mercantile affairs in Philadelphia.

Here he was united in marriage with Jane, a daughter of John and Margaret Cummings of this city. The issue of this marriage was nine children; of whom six died in their infancy, leaving him one daughter and two sons, James and an infant child, Samuel George Morton, of whose character we are to speak.

Mr. Morton, still engaged in commercial pursuits, which had not as yet yielded him the golden fruits of fortune, was suddenly cut off by illness on the 27th July, 1799, leaving the young child an orphan only six months old. The widow and her three children thus bereaved, and left with limited resources, withdrew from the city, retiring to a place a few miles from the city of New York, called West Farms, which was at the time a settle-

* Read November 6, 1851, and published by direction of the Academy.

ment under the chief direction of the people called Friends or Quakers.

Here Mrs. Morton experienced much friendly regard, and her children kind protection, from the benevolent people among whom she had chosen her lot. Although not originally a member of the Society of Friends, she had relations or connections among them, and was, after a time, led to enter the society as a member, and to wish that her children also should be received, which was done; so that young Samuel being formally taken within their protecting fold, his earliest years were passed in the training and discipline of Friends.

As soon as the orphan was suited by age, he entered the school at West Farms, and was there taught the rudiments of letters. A memorandum in his diary shows that the first twelve years of his life were passed under this discipline; one in which he learned those lessons of moderation and self-control that are best received in the tender plastic age, before the loud voices of the passions have risen above the whispers of reason.

The progress that he made in learning, if we may take his own statement, was not so great as could be desired. Nevertheless, he had already acquired a passionate fondness for books of history, which he devoured; and he discovered an early taste for poetical composition, and was greatly addicted to the writing of verses. It is reasonable, therefore, to suppose that while his advances in school learning may have been slow, his spirit was already up and striving to escape from the barriers with which immature age and other circumstances had hemmed it in.

Morton's love for historical studies, thus early awakened, never ceased in all his after life; and it formed, perhaps, a principal element in his subsequent destiny. His love of poetry, too, and versification, accompanied him to the latest period of life; and though unknown as one of the poets of America, he improved his natural talent in that way to the production of pieces, showing him to possess a lively perception of the beautiful and sublime in nature, and a quick sympathy with every gentle and noble sentiment.

In the year 1808, the elder brother, James Morton, was invited to visit his uncle, Mr. James Morton, who lived in affluent circumstances at Clonmel. This kind intention to protect and aid his deceased brother's son was defeated by the death of the lad, which occurred at Clonmel, about 1811. The younger and now only remaining son was yet diligently occupied at the Friends' School, and though we have reason to believe he displayed no little readiness in learning, he complains that what he "learned in seven years, might, with a proper tuition, have been mastered in two." So that he was never content with the earliest of his lessons. After this he passed some time at Friends' School at West Town, Chester county.

In the autumn of 1813 he was in his fifteenth year, and for the purpose of higher teaching was transferred to the school then held at Burlington, New Jersey, under the auspices of John Gummere, of the Society of Friends, a gentleman of enviable reputation as an instructor of youth and as a highly cultivated and conscientious man. Here he spent six months under Mr. Gummere's tuition, devoting himself principally to the study of the mathematical sciences. In after years he was wont to reflect with much satisfaction upon this portion of his life, as one very profitable for his instruction and improvement, and he expressed the opinion that it was the only school in which he "derived knowledge commensurate with the time and labor consumed in study," yet even here he had occasion to lament that he did not learn as much as was to be expected; because he was wanting in the first principles of education. This was a reflection that appears to have distressed him; yet to it is perhaps due the great pains he subsequently took to make amends for early deficiencies.

Although placed under Mr. Gummere's care, and loving his work, Morton did not even there acquire any strong bias or affection for mathematics. He still preferred history, in the reading of which he took extravagant delight. Mr. Gummere's school was the last one that he attended.

Thus we see that young Morton, early cast upon the world without good educational training, was enabled, through his own resolute will and an innate affection for learning, so far to master every difficulty as to rise above the hopes entertained of him, and succeed in his scheme of life better than thousands of his cotemporaries, to whom every possible advantage was extended.

Leaving the Burlington school, young Morton now came to Philadelphia in the summer of 1814, to be entered as an apprentice in a merchant's counting-house, with a view to be fitted for the management of general business.

From his first entrance upon the duties of the mercantile house, he was impressed with a seated conviction that such was not his vocation, and it was ever an irksome task to fulfill the duties of his station there. Yet while strictly observant of his place, he found occasions in the pauses of his work to gratify his love of books.

In the year 1817, he lost his mother, which was a grievous loss to him. He fervently loved her on account of the tender regard she merited by her gentle and affectionate deportment to her children.

In the autumn of the same year, he got possession of a copy of Dr. Rush's sixteen Introductory Lectures, which he read with such delight that he definitively resolved, after their perusal, to adopt the profession of their celebrated author, and he never afterwards had real occasion to repent his determination to take so important a step.

At that time the late Dr. Joseph Parrish, who was at the height of his reputation as a physician and teacher, was accustomed to receive into his office many young gentlemen, students of medicine, who were there instructed by him. Dr. Parrish had also several assistants—young physicians, who joined in the instructions given in the school, by way of familiar lectures and demonstrations. This was the medical school into which Morton entered as a student, in 1817; and it was fortunate for him to be placed under such excellent tuition—one that has sent forth many physicians who have acquired celebrity both in medicine and the collateral sciences.

While under Dr. Parrish's private tuition, Morton attended the courses of medical lectures at the University of Pennsylvania, where he learned Anatomy and Physiology, Therapeutics and Materia Medica, as well as the principles and practice of Physic and Surgery.

These educational pursuits served in a good measure to supply the deficiencies of his earlier training. Nor can it be denied that these departments of medical learning do coincide with very expanded and liberal views of nature; and that the study of them leads to an acquaintance with the laws and phenomena of both the inorganic and the organic.

It may, I hope, be allowed me to remark here, that these studies, if rightly pursued, might well serve to retrieve one's losses of time and errors of aim, through imperfect tuition in schools and colleges; and that it is not surprising that a youth, faithful to himself as Morton was, should have issued from such a medical school, far more advanced in useful knowledge, than he would have been by the devotion of an equal amount of labor and time in the ordinary academies or colleges of the United States.

Seeing how strong was his natural desire for mental improvement, one might well envy the happiness experienced by such an individual while imbibing the great and diversified streams of information so refreshing and strengthening to the spirit of an eager and thirsty aspirant. Such happiness is greatly to be desired as gratifying a commendable spirit and as laying up at the same time, treasures of knowledge, the dispensation and administration of which, for the benefit of others, afford a clear expectation of often renewed and calm delight during the lapse of a long and busy life.

I believe that in his studentship, Morton attended three courses of lectures at the University, and having at length complied with the rules of the institution in all respects, he was admitted to the degree of Doctor in Medicine at the Commencement, held in 1820. He was, in the same year, April 16th, 1820, elected a member of the Academy of Natural Sciences.

Though crowned with the honors of the University, he was not, as many young men are, puffed up with exaggerated notions of his abilities and accomplishments, for he was an unassuming, modest young man, who yearned for further and fuller knowledge not of his profession only, but of things and men—particularly of eminent physicians. He was also moved by a laudable desire to see and know those of his kinsfolk who still resided at Clonmel, the seat of his family and his ancestors, who equally desired to be acquainted with their young American relative, the only remaining son of a deceased beloved brother.

Accordingly, on the 10th of May, 1820, he embarked at New York, for the port of Liverpool, to visit them, agreeably to the warmest invitations from his uncle, Mr. James Morton of Clonmel, the same gentleman to whom, as his "Venerable Uncle," he afterwards gratefully dedicated the most considerable of all his works, the Crania Americana.

After a prosperous voyage he had the happiness to find himself surrounded by a numerous society of relatives and connections living in the most agreeable style, and possessed of manners, which could not but have a salutary influence upon him, and doubtless tended to impart to his own manners something peculiarly dignified, tempered by an extreme affability and urbanity, which ever afterwards distinguished him as a gentleman.

Morton did not, amidst the gay convivialities of his house, abandon himself to the pursuits of pleasure, but wisely devoted a portion of his time to studies that were occasionally broken in upon by journeys and by invitations to their hunts, their coursing the hare, their salmon-fishings, and their parties. He kept a regular diary of his proceedings, which shows that he was an attentive observer, not only of events and of nature, but of his own short-comings and his deficiencies in manners, in address, and his views of the world as it is. His diary shows him to have had, even at that time, a spirit earnestly engaged with itself in improving and strengthening its faculties, and rightly directing its aspirations.

Mr. James Morton, who soon became warmly attached to his nephew, was not satisfied that he should be content with the doctorate conferred by an American University, and insisted that he should possess himself of one which he regarded as more authoritative and distinguishing, namely, the Diploma of Edinburgh, at that day still boasting of some of its old celebrated names. Accordingly, it was determined that he should attend the curriculum at that school, with a view to obtain its honors.

Dr. Morton had reached Clonmel on the 14th of June, 1820. It was on the 20th of October that he arrived in the capital of Scotland to enter as a matriculate in the University.

Here he diligently attended the lectures of Professor Munro the younger, of Prof. Hope, Prof. Home, both the Hamiltons, and with great delight the geological lectures of Prof. Jameson. The last-named gentleman inspired him with a warmer zeal for natural science, though it is probable that his connection with Dr. Harlan, who had been one of Dr. Parrish's assistant instructors, had inducted him already into some positive acquaintance with and fondness for such studies.

Dr. Morton also attended the course of lectures delivered by the celebrated Prof. Gregory at the Edinburgh University, up to the period when those elegant discourses were terminated by the attack which resulted in the Professor's death on the 3d of April, 1821.

After a violent, dangerous, and protracted illness, which he suffered in the early part of 1821, and which brought some of his friends even from Clonmel to assist and console him, Morton made a tour in the Scottish highlands. The journal of this tour shows that, while he had a poetical sense of the beautiful and the sublime in Nature, he also cherished a habit of philosophical observation, and that he returned strengthened in body, and enlarged in his views by the visit to that interesting region. After a short delay at the capital he returned to Ireland to unite himself again with his family at Clonmel.

As Paris was then looked upon as a chief radiating point of medical science, it was determined that he should pursue his further medical studies there. Accordingly, he bade adieu to Clonmel again on the 4th day of October, and passing a few days in London and at other interesting points in England, he arrived at Paris on the 26th of the month.

Here he devoted himself very assiduously to his tasks as student, indulging very sparingly in the amusements and distractions of that seductive city. He was always on his guard against its temptations; and very frequently had before him the image of his deceased mother, as if warning and guarding him in the slippery paths of his youth; for he said that her spirit seemed to be always with him and about him; and that it was a sore trial of his young life, that by no longer adhering to the Society of Friends, he might grieve that gentle and loving spirit. He had tenderly loved his mother during her lifetime, and cherished her memory while he himself lived.

He told me that, when the carriage rolled out of the gates of Paris on his way to Italy, he looked back towards the metropolis, and upon the smoke and dust above it, and, raising his eyes and hands towards Heaven, ejaculated his thankfulness to be delivered from the moral contagion in which he had lived there, and thought of the cities of the plain.

No memoranda of his proceedings were made during his residence in Paris, but in his resumed journal he remarks that the past winter was the happiest of the three-and-twenty that had passed over his head, and that he had endeavored so to combine study with amusement as not to become weary of either.

He proceeded to Geneva and made an excursion along the wild romantic Glen of the Arve to the Vale of Chamounix. * * * *

Our traveller, pursuing his journey, visited Milan and Pavia, and thence proceeded to Turin. In fine, he spent the summer in visiting various places upon the continent.

The following winter was passed at Edinburgh again in sedulous attendance upon the lectures, and in active business at the Infirmary; so that, he certainly enjoyed remarkable opportunities to become acquainted with matters of his profession and make amends for the deficiencies of his early instruction.

At the commencement at Edinburgh held in August, 1823, he presented an elegant Latin Thesis, *de Corporis Dolore*, and having fulfilled the requirements of the Institution in his examination, was passed Doctor of Medicine of that school.

Certainly Dr. Morton must have now acquired solid claims to the character of Physician, in which vocation he was about to present himself in his native city; for he had commenced his studies in 1817, under a meritorious and able private teacher, and so had six long years of earnest studies and constant progress.

Dr. Morton ever looked with distrust upon his early education, which he regarded as incomplete, and therefore unsatisfactory; and hence he was always alive to the need of repairing the faults of it, if he would aspire to a dignified station in the great scholarship into which he was entered by the closing of his student-life. He applied himself therefore to obtain many accomplishments, so necessary for his purposes, in languages, in belles lettres, and what may be called matters of taste. He, however, still loved his history and poetry. His diary contains many selections and translations, both in prose and verse, from various Italian authors, whose language he read with facility.

He had acquired a good acquaintance with the Latin and French tongues, and some knowledge of the Greek. He never had leisure or pause from work to allow of his becoming master of the German language, which was always a subject of regret to him.

I cite these memorials of our departed friend and colleague the more willingly, inasmuch as they evince Dr. Morton's earnest appreciation of the advantages likely to enure to every scholar who will secure such facilities, while they also prove his good sense and prudence in early life; for he devoted himself to study, while others, loitering by the way, were happy to have escaped the thraldom of a pupilage or the trammels of a studentship, and so fell into habits of ease and self-indulgence. The example is well fitted to be handed down for the imitation and encouragement of any youth, who would become a wise and accomplished gentleman and scholar.

It was in June, 1826, that Dr. Morton presented himself to the citizens of Philadelphia, as one of the physicians of the place. But the first appeals of the young physician fall upon ears that are deaf; and he determined that, while slow progress must be submitted to, time should not be lost. He renewed his connection with the Academy, which at that time embraced many names that need only to be pronounced, to show how ardent was the love of natural science here. Maclure, Ord, Lea, Say, Collins, Lesueur, Nuttal, the beloved and lamented Griffith, Harlan, Pickering, Conrad, and others, were inspired with a zeal that knew neither tiring nor satiety. The meetings of the Academy, which had before been held at the old hall in Arch street, were, in 1826, transferred to the new museum in Twelfth street, where Morton labored, with the others, in classifying and arranging the cabinet. Here he delivered an address, which contained an interesting history of the Academy from its foundation, and which has passed to a third edition.

His first scientific, published essay, was an article *on Cornine, a new alkaloid*, printed in the *Med. and Phys. Jour.* for 1825–6, p. 195.

May 1st, 1827, the young naturalist presented his first scientific communication to the Academy, which was entitled, *Analysis of Tabular Spar, from Bucks county, Penn., with a notice of various minerals found in the same locality.*

This paper, which was creditable to him, was followed by a long catalogue of articles, some of them very important, but too numerous and various to be cited here. They are enumerated at the end of this memoir.

The discovery of numerous marl-beds containing organic remains, in the State of New Jersey, and the extensive excavations of the Chesapeake and Delaware Canal, at that period in process of construction, furnished provocatives and aliment to his appetite for research; and his diligence enabled him to make numerous valuable contributions to the Academy's Journal, upon the subject of organic remains, and geological formations. More than fifty of them are noticed in its volumes. He also made contributions to the Am. Philos. Society, some of which are published in its Transactions; particularly his learned, ingenious, and admired essay, entitled *Crania Ægyptiaca*, which shows his ripe scholarship, and the fervency of his thought. This essay greatly enlarged his reputation abroad, and won the esteem of distinguished scholars.

To Professor Silliman's *American Journal of Science and Arts* he made valuable communications, and it is only necessary to turn over the volumes of his great correspondence, to perceive how largely the opinion of him was enhanced, especially by his celebrated essay on the *Cretaceous Group of the United States*, which contained a synopsis of the organic remains to be found in it; a work of much labor and research. His correspondence shows that this paper gained for him high credit, and drew forth happy compliments upon his ability, candor, and discrimination.

I shall beg your permission to remark that we have here a conclusive proof as to one point of Dr. Morton's character; I refer to what may be called his good sense; for it is in this country, and probably elsewhere, an evidence of good sense, when a medical man devotes himself with success, to the pursuit of Natural History, or any cognate study, without complete ruin to his prospects as a practitioner. * * *

He had early begun to make his now celebrated collection of crania, with great labor and toil, and inconvenient cost. He investigated organic remains; he explained problems in zoology and ethnology; he diligently attended the sick; he published valuable treatises on consumption, on the science of anatomy, and on the practice of physic. He served the city gratuitously, as physician to the Almshouse Hospital, and delivered courses of lectures at the Pennsylvania Medical College, where he was Professor of Anatomy. All these things were done by a man whose family was large, and chargeable upon his funds, derivable in chief from his exertions as a physician. Is it too much to say that a man who could do this, and acquire in the mean time, the reputation of being one of the most considerable physio-philosophers of the Western Continent, was both a wise and learned man? Yet nothing could make him either vain or arrogant.

Upon a late occasion, a gentleman returned from foreign travel, reported a compliment paid to him abroad in one of the very highest quarters in the whole republic of letters. Dr. Morton replied: "I beg you never to repeat that. I assure you it will be disagreeable to me ever to hear of it again." Yet certainly, if a man might accept a compliment, he could not desire a better or more disinterested one than that was which pronounced him to be the American Humboldt.

In 1834 Dr. Morton made a voyage to the West Indies, which gave him opportunity to investigate points in relation to their geological structure.

On the 18th September, 1839, he was elected Professor of Anatomy in Pennsylvania Medical College, which office he vacated November 6th, 1843.

I have mentioned his collection of crania. His earliest publication on ethnology was the splendid volume illustrated with beautiful lithographs, entitled *Crania Americana*, fol., Philadelphia, 1839. Here I shall feel myself authorized to detain you a few moments in relation to some points connected with that elaborate work, which will continue a lasting monument of his learning, energy, and ability.

It is a very remarkable circumstance that men of science, and particularly the cultivators of the natural sciences, had, to a certain extent, forgotten to attend to the records of man as creature merely, and member of the zoological series, whose form and other physical attributes it would be interesting to know, as they have existed during the long persistence of that imperishable unit, the Genus Man.

Elucidations of man's ethnological characteristics could be best drawn, not from the historian, the geographer, or philologer, but from the observation of his real physical attributes in various zones, climates, continents, and epochs. Such investigations might well serve to throw a brilliant light upon many dark questions both in history and chronology, as well as in morals and faith.

No unquestionable palæontological remains of the race have ever been discovered, and Scheuchzer's *Homo Diluvii testis*, M. De St. Merry's Martinique Galibis, and the remains from Santas, in Brazil, were alike rejected as no antediluvian records.

That illustrious physiologist, Prof. Blumenbach, was the first to point out this *lapsus* of regard on the part of the learned, and to take measures to repair the wants of science in relation thereto. He accordingly commenced his collection of human crania, and in the year 1790 published the first of his *Decades Craniorum*, which work was continued at intervals until the last of the Decades appeared, in 1828, having been in course of publication for a period of thirty-nine years.

These Decades contain the highly expressive outlines of sixty-five crania with faint linear shadings, representing the peculiar form and appearance of various races and families of mankind. They are highly expressive delineations; because they convey most explicit notions of the cranioscopical peculiarities of different races of men.

Blumenbach was surprised to find that, in the course of more than three centuries since the revival of letters, during which the industry and zeal of the learned had been exercised in making natural history collections, *ad luxuriosum fere usque excessum*, it was, as yet, almost impossible to meet, in the richest museums, with any specimens illustrative of the natural history of man; and further, he was astonished to learn that the subject had been neglected by the most classical and voluminous writers of past times, and that even Conrad Gesner and John Ray had passed it by in silence.—*Dec. Cran.* I, 4.

Animated, therefore, with the idea of that important aid which might be given to the progress of knowledge by filling up this lacuna, he made his celebrated collection, and issued the publications before mentioned which were founded upon it. Much of his fame as a philosopher is derived from these labors. But, if the celebrated German has received meet praises for this work, shall we not also claim for an American physician and naturalist a share of applause for labors more assiduous, and results far more considerable and valuable?

The augmentation of his museum of crania of men and animals, made Dr. Morton, doubtless, to a great extent, aware of those cranial homologies so curiously set forth by the illustrious Oken, and which, if they may be clearly assumed as of the lower animals in various genera, must become in man merely differential ones; yet still, as Blumenbach and others, but most of all Dr. Morton have shown, easily appreciable. As ethnological attributes or marks, he certainly learned to discriminate and use them with great facility and exactness.

His valuable museum grew steadily up to the close of his life by frequent additions gathered from the whole world; and even since his death valuable specimens designed for it have arrived from foreign parts.

I desire not, gentlemen, to give undue praise to the subject of this memoir, and it is not from any such promptings that I beg to refer you to the eulogy pronounced by Dr. Pariset upon Cuvier, at the *Acad. Royale des Sciences* of Paris, July 9, 1833. Dr. Pariset wished to show how energetic was the spirit of Cuvier, in regard to the *Mus. d'Hist. Nat.*, at the *Jard. de Plantes;* and speaking of his appointment there, he says, "Il entre au muséum, et n'y rencontre que quelques squélettes incomplets ou vermoulous, qu'il faut tirer de la poussière. En quelques années plus de quatre cents squélettes de mammifères; plus de douze cents préparations osseuses; plus de seize cents organes d'animaux à sang-rouge et à sang-blanc conservés dans de l'esprit de vin, sortent des mains de Cuvier."

"C'est ainsi que, secondé de Rousseau et de Laurillard, ses fidèles ses zélés coopérateurs, il forme par dégrés chaque année, ou plutot par des rapides progrès, cette magnifique galerie d'Anatomie Comparée, la plus riche de l'Univers, où l'on compte aujourd'hui plus de deux mille cinq cents squélettes de mammifères, et d'oiseaux, de reptiles, de poissons; plus de quatre mille préparations osseuses; plus de six mille préparations d'organes; en tous plus de quinze mille pièces, dont plus de quatorze mille n'existaient pas avant lui."

Even the gentle and modest spirit of our deceased friend would take no alarm at this statement, which is not offered with a view of comparing him with the illustrious Frenchman, which is farthest from my thoughts. But I have cited the paragraphs merely to show how such great activity and zeal for science are, and ought to be estimated; yet I wished at the same time that some due estimate should be made of Dr. Morton's merits in a similar line of scientific effort. Dr. Morton began alone, and with nothing; without the patronage of government, or the assistance of imperial or royal treasuries, and with no Rousseau or Laurillard: yet, by means of his own pecuniary resources, never superabounding; overwhelmed with professional business; ofttimes in miserable health and in danger of death, he had, so far back as the year 1840, collected and arranged a cabinet of 867 human crania, from many widely separated regions of the earth, 253 crania of mammals; of birds 267, and of reptiles and fishes 81—making 1468 specimens, the number of which in the course of the last ten years has been very considerably increased.

I think that this is a just and yet modest exposition of his liberality, perseverance, and labor in behalf of science, leaving out of consideration the fatigue of so great a correspondence as was necessary to effect his object, and the inconvenient expenses, without which it could not have been carried on.

Dr. Morton never would have encountered all these toils for the gratification of mere curiosity, nor for any other purpose save that earnest one of getting at results, useful and applicable truths, to be turned to account in investigating the natural, moral or political history of man—objects in science surely not less interesting and exciting than the infusorials of Prof. Ehrenberg, or the metamorphoses of Sars or Steenstrup.

To compose and publish a great work in America is a bold undertaking on the part of an author. But, notwithstanding the demands of a growing family, which he loved with a love akin to idolatry, and for whom he desired to secure the priceless benefits of education, which he always deemed better than gold or much fine gold, or any endowment with worldly estate, he undertook, in 1839, to publish his great work, *Crania Americana*, which should contain the fruits of his labors and researches; and he also resolved that it should at the same time serve to illustrate an important department of the Arts in Philadelphia.

All this he did when he gave us his sumptuous volume, the *Crania Americana*, which issued from the press in 1839.

Notwithstanding this work did not, in his native city, produce the impression, and meet with the success which, from a liberal spirit among this community, might have been expected; the bare announcement of it brought numerous inquiries from abroad, showing the desire of many learned and eminent persons to know to what results it might lead. In an appendix (p. 179, beyond) I have placed a letter from Baron Humboldt, which gives it the highest commendation.

Upon its publication it was welcomed, in the *American Journal of Science and Arts*, as "the most important, extensive, and valuable contribution to the Natural History of Man which has yet appeared on the American Continent.

"The subject," it was added, "is one of great interest, and Dr. Morton has treated it in a manner at once scientific and pleasing, while the beauty and accuracy of his lithographic plates are not surpassed by any of the modern illustrations of science." Such was the language of that most respectable Journal; and which allows me to say, *pulchrum est laudari à laudato viro.*

The *Medico-Chirurgical Review*, the *Western Journal*, the *British and Foreign Medical Review*, the *Journal of the Royal Geographical Society*, the *Eclectic Journal*, and that time-honored, able, and impartial work, the *Edinburg Medical and Surgical Journal*, all contain the most flattering encomiums upon Dr. Morton's labors.

I have no right to draw forth for the public from many private letters to him that I have had the pleasure to examine, the favorable sentiments and expressions of distinguished Naturalists and Archæologists, addressed to our deceased President upon the appearance of the *Crania Americana*. Could I with propriety do so, I might show you how great was the consideration it acquired for him in the highest literary and scientific quarters.

The work is on your table, and you are acquainted with its purposes and its contents as to our American Ethnology and Archæology.

You know that he considered "the Human species as consisting of twenty-two FAMILIES."

He did not assume that these FAMILIES are "identical with RACES, but merely groups of nations possessing, to a greater or less extent, similarity of physical and moral character and language."

He professes his belief in a primitive distribution of mankind into races, in the sense of their having been originally adapted to their local destination.

In classifying the races, he chose to adopt Blumenbach's methodical arrangement of those great divisions, *videlicet*, a Caucasian, a Mongolian, a Malay, an American, and an Ethiopian race.

Out of these divisions or races, he formed the seven families of the Caucasian race; as the Caucasian, Germanic, Celtic, Arabian, Lybian, Nilotic, and Indostanic families.

The Mongolians make five families; which are Mongol-Tartar, Turkish, Chinese, Indo-Chinese, and Polar families.

The Malays are two, the Malay family, and the Polynesian family.

The American race consists of the American family and the Toltecas.

The Ethiopian division comprises the Negro, Caffrarian, Hottentot, Oceanic-Negro, Australian, and Alforian families.

It would be no unpleasing task to exhibit here, in a concise manner, the exemplification, by many of his facts, of the justness of his views on these several topics; particularly as his pages are replete with interesting details and descriptions that render the volume a charming as well as a most instructive one. The style is grave, yet full of fervency; and the whole work is as modest and devoid of arrogance as Dr. Morton himself.

Humboldt compliments him by saying that his work is destitute of those poetical reveries which may be regarded as the myths of modern physiology.

It is far less loaded than the celebrated *Natural History of Man*, by Dr. Prichard; but in many respects it is equally deserving. We may well consider our country to have been honored by its publication.

I shall not add any further remarks upon it here beyond the expression of my hearty concurrence with the opinions of the *American Journal of Science and Arts*, as to the beauty of the lithographic heads, of the fidelity and truthfulness of which it needs only to be said that he was scrupulously honest to that degree as to condemn and cancel several completed lithographs, most perfectly executed save in some minor, yet, to his acute sense of truth, inadmissible want of perfect accuracy.

Want of time compels me now to turn to another of his highly interesting labors. I allude to the Crania Ægyptiaca, which, as I said before, was a communication made to the *American Philosophical Society*, in December, 1842, and January and April, 1843, and published as an independent work, entitled "*Crania Ægyptiaca, or Observations on Egyptian Ethnography, derived from History and the Monuments:*" Philadelphia and London, 1844, 4to., with plates.

This volume contains fourteen plates, with views of 98 heads, besides numerous very excellent wood-cuts inserted in the running text; and it may safely be said of the treatise, that though strictly a scientific production it is one highly pleasing even to the general reader, by the interesting nature of its topics, and by the relation, as the story proceeds, and the *perfervidum ingenium* with which it is pervaded.

His inquiries enabled him to come to the following conclusions:—

"1. The valley of the Nile, both in Egypt and in Arabia, was originally peopled by a branch of the Caucasian race.

2. These primeval people, since called Egyptians, were the Mizraimites of Scripture, the posterity of Ham, and directly associated with the Lybian family of nations.

3. In their physical character, the Egyptians were intermediate between the modern European and Semitic races.

4. The Austral-Egyptian or Meroite communities were an Indo-Arabian stock, engrafted on the primitive Lybian inhabitants.

5. Besides these exotic sources of population, the Egyptian race was at different periods modified by the influx of the Caucasian nations of Asia and Europe—Pelasgi or Hellenes, Scythians and Phœnicians.

6. Kings of Egypt appear to have been incidentally derived from each of the above nations.

7. The Copts, in part at least, are a mixture of the Caucasian and Negro, in extremely variable proportions.

8. Negroes were numerous in Egypt. Their social position in ancient times, was the same that it is now; that of servants or slaves.

9. The natural characteristics of all these families of man were distinctly figured on the monuments, and all of them, excepting the Scythians and Phœnicians, have been identified in the catacombs.

10. The present Fellahs are the lineal and least mixed descendants of the ancient Egyptians; and the latter are collaterally represented by the Tuaricks, Kabyles, Siwahs, and other remains of the Lybian family of nations.

11. The modern Nubians, with few exceptions, are not the descendants of the Monumental Ethiopians; but a variously mixed race of Arabians and Negroes.

12. Whatever may have been the size of the cartilaginous portion of the ear, the osseous structure conforms, in every instance to the usual relative position.

13. The teeth differ in nothing from those of other Caucasian nations.

14. The hair of the Egyptians resembles in texture that of the fairest Europeans of the present day.

15. The physical or organic characters which distinguish the several races of men are as old as the oldest records of our species."

Such are the inferences to which our president arrived after his long and arduous studies.

Dr. Morton, whose Museum I have so often alluded to, was naturally led by his ethnological studies to give a portion of his thoughts to what is called Egyptology, wherein he might haply derive materials for conclusion, very satisfactory to the mind, since the studies of the learned had lately acquired the highest importance as regards the fixing of many interesting chronological points.

The strata of the earth having hitherto disclosed no debris of antediluvian or palæontological man, if he could go back to the tombs and catacombs of the cotemporaries of Abraham and the Patriarchs, he might well hope ethnologically to verify specimens of the most ancient date, in his museum. Hence the foundation of this work, the *Crania Ægyptiaca.*

Fortunately he instituted a correspondence with a gentleman long an inhabitant of Egypt, and, by his varied erudition, and the most versatile talents and untiring zeal for learning, the fittest person in the world to aid him and promote his ends. I speak of Mr. George R. Gliddon, whose enthusiasm for Morton appears to have known no bounds; so that he was indefatigable in the search for and in forwarding to Dr. Morton, specimens of crania taken from various localities in Egypt, and so verified as to their chronological epochs and places as to give them the highest value as cabinet specimens. It is only necessary to refer to Dr. Morton's published works to see how effectual was the assistance he derived from that zealous and warm-hearted friend. But I cannot detain you longer with a relation of all that Mr. Gliddon effected and proposed in behalf of the subject of this memoir, nor can I sufficiently express my admiration of the heartiness and the spirit-like enthusiasm with which he helped and loved Morton.

They were both greatly moved by the disclosures of the Egyptologists, nor is it surprising they should have been. * * *

Dr. Morton, in his *Crania Ægyptiaca*, p. 39, asks the question, "Who were the ancient Egyptians?" and is inclined to admit the connection between the old name of Misraim the son of Ham, and Mizraim the old name of the Egyptians, as used by the Hebrew writers.

It matters not for the present, whether this idea be well founded or not; I having it in hand, only to show you where and in what manner Dr. Morton's thoughts were directed.

Perhaps Professor Rossellini may, with greater reasonableness, derive Misraim, or Mestraim, as Eusebius writes it, from *Tzur* a rock, or rocky-pass, whence *Matzur*, a fortress or castle. Rossellini says that Mitzraim is a word of dual signification, curiously indicating two rocks, to wit, the two rock-chains, Lybian and Arabian, that on either hand compress the valley of the Nile between their bases.—*Ross. Monumenti d'Egitto e Nubia*, i, 18.

Whether this question of Dr. Morton's can be best settled by the philologer or the archæologist, I shall not attempt to decide; yet I venture humbly to submit, that, in answering the query as to who were the Egyptians, it seems reasonable in him, to have thought that, if a word, or a name, or even a whole language can clear up the point, or if the stone stelæ, obelisks, temples, pyramids, and palaces can answer our demand, a plainer and more satisfactory solution is to be found, by bringing before us the very Egyptians themselves, as Dr. Morton appears, in some instances at least, to have successfully done. It is true that the skulls he describes, as from the pyramid-of-five-steps, he has not positively declared to be coeval with that most ancient structure; but if they are so, then they may, he thinks, be regarded as the most ancient human remains at present known. Certainly they exhibit characteristics of the Caucasian race.

Of course it is not for me to entertain, much less express any opinion on the cotemporary age of Dr. Morton's specimens, and the new chamber discovered by Mr. Perring, in which they were found under circumstances leading to a suspicion of their extremest antiquity. Dr. Lepsius says of that pyramid land of Gizeh, Saqara, and Daschur, to which alone the Prussian commission devoted six whole months, "Wer sich aber, auch nur an die niedrigsten Annahmen der neueren Gelehrten über das Alter der ersten Ægyptischen Dynastieen halten wollte, würde noch immer jenen Denkmälen die Priorität vor allen übrigen Ægyptischen, so wie überhaupt vor allen geschichtlich nachweisbaren Kunstresten des ganzen menschlichen Geschlechts zugestehen müssen."—*Lepsius*, *Denkmäler aus Ægypten und Æthiopien*, p. 4.

But admitting that these skulls are as old as the foundation, you may start the question whether Dr. Morton could, in an immense collection of crania of all nations and of diverse epochs, unerringly select, and classify, and denominate those of the five divisions or races, and even families of mankind.

For my own part, I confess I long thought that his was a labor in vain; since to a casual observer as I was, the appearances noticeable in a great number of specimens are so similar, that I doubted the applicability of any rules of cranioscopical discrimination to the ends he had in view.

I now, however, fully admit that I did him injustice in the thought, which arose only from my own ignorance of the subject. I now believe that Dr. Morton's diagnostications as well as Blumenbach's, are to be depended upon; and that Dr. Morton's discrimination of the different skulls in his collection was so fine and delicate, that I cannot reject his indications and explanations of ethnological characteristics in them. I find an incident, mentioned in the diary, which I beg leave to relate to you, which is contained in a letter of his to his friend, George R. Gliddon, Esq., under the date of March 7th, 1845. The following extract from it, which I beg permission to read, gives proof of the ability with which he applied his cranioscopical learning to ethnological questions.

* * * * * * * * *

"yesterday sent me a copy of Bonomi and Birch's *Egyptian Antiquities of the British Museum*, which comes in good time, and is very welcome. Let me give you an example of the manner in which the study of physiognomy comes in aid of archæology. One of the first plates I examined was the third, fig. 36, which represents the Ægis of Athor, the Egyptian Venus. I was at once struck with the resemblance of the profile to that of *Aamesnofri-ari* (*Cran. Ægypt.*, pl. 14, fig. 13), Queen of Amunophis the First; and on the principle that it was the custom of the Egyptians to make the features of the god resemble those of the monarch under whose reign they were executed, I was led to suppose that this effigy must in some way be connected with the Eighteenth Dynasty.

"Judge of my surprise and pleasure, upon reading the text, to find that this figure pertained to that very dynasty, though without any reference to the likeness between the effigies of the goddess and that of the queen."

If I am correct in these opinions, and if you coincide with them, certainly you will agree with me in deeming Dr. Morton warranted in bringing the light of his knowledge in these particulars, to bear upon the dim traces of man's lost history; and you will, upon due reflection, thank him even more than you have already done, and revere his memory and applaud his actions, who has built up that valuable collection now in your museum. That museum of yours is the scientific glory of the United States; and, it is fondly to be hoped, that the wealth and the luxury of Philadelphia, its fame for letters and philosophy, will not soon have occasion to be ashamed and penitent; as it must be, if that admirable collection, the fruit of so much toil and care, should be greedily and pitilessly taken from you, not by the greater wealth, but by the far greater liberality and public spirit of foreign nations or individuals. * * *

My duty now brings me to touch upon a subject of extreme delicacy; one which I should pass by in silence were it not that by doing so I should fall far short of a due obedience to your commands, which are to present to you a memoir of Dr. Morton.

I allude now to his published opinions on hybridity, involving notions upon the origin of the human race that brought him into conflict of opinion with others, whom he would be pained to disturb in their sentiments, and whom he could not expect to unsettle in matters of religious faith. Indeed he was peculiarly averse to such proceedings, and I happen to find in his diary, for Dec. 8th, 1849, an entry which shows his abhorrence of infidelity.

"Some self-sufficient Christians," says he, "endeavor to make other persons unhappy in their faith, by representing them as victims of delusion. Such attempts to destroy the sacred tranquillity of the human mind under its conscientious impressions of right and wrong are equally cruel and wicked with those of the true infidel, who would destroy our hope in the future by trying to convince us that there is no overruling Providence, and no existence beyond the grave."

Why did Dr. Morton make this entry into a private record of his thoughts? Certainly not with the expectation that I should see, or you should hear it.

In the *Crania Americana*, published in 1839, now twelve years ago, he had expressed his doubt as to the origin of mankind from a single pair, and he said, that "the prevalent belief is derived from the sacred writings, which, in the literal and obvious interpretation, teach us that all mankind must have originated from a single pair; whence it has been hastily and unnecessarily inferred, that the differences now observable in mankind are owing, solely, to vicissitudes of climate, locality, habits of life, and various collateral circumstances." And he asks whether man was not at once adapted by his Creator to the physical and moral circumstances in which he was to dwell upon the earth. He deems "that we are left to the reasonable conclusion that each race was adapted, from the beginning, to its peculiar local destination."

You perceive that Dr. Morton here asserts the physical characteristics of different races, as Europeans and Negroes, for instance, to be independent of external causes, and so aboriginal; or that the white man and the Malay, the North American Indian and the Hottentot, are people who could not have descended from the same original pair.

These views, which were forced upon him by an examination of the case, were not adopted without a reverent search of the sacred Scriptures.

The question before him was not whether all mankind are brethren, in the sense of being of the same species and under the same moral law, which as men they could not escape from being. It was a question relative to important facts in natural history and physiology.

He could not geologically admit that the Noachian deluge could at once cover the whole of the earth's surface; and he concluded that, if that great cataclysm which broke up the fountains of the deep, drowning vast extents of the earth, did leave some continents or parts of continents unsubmerged, the Scriptures would be rather strengthened and confirmed in their authority and dignity, than robbed and diminished in these respects, by a true reconciliation with the facts of geology, palæontology, and ethnology.

He thought the exceeding great populousness and the intellectual power and progress of the nations that existed at the founding of the pyramids, could be more reasonably accounted for by supposing a plural origin of pairs of the same moral stamp and responsibility, power and destiny, than by the natural increase and dispersion possible in so short a time as elapsed between the submergence of the deluge and the founding of those vast structures at Gizeh, Abusir, and Daschur—edifices which, whether laid by the hands of Menes or Cheops, go back to a remote date, now chronologically determined, beyond the days of Abraham.

These reflections led him to draw up a paper which was printed in the *American Journal of Science and Arts*, vol. ii, 2d Series, 1846, and entitled, "Some Observations on the Ethnography and Archæology of the American Aborigines." This was followed by an "Essay on Hybridity in Animals and Plants, considered in reference to the question of the Unity of the Human Species;" read at your table, but published in the *Am. Journ. of Science and Arts*, vol. iii, 2d Series, 1847.

The facts recited in these essays authorized him, as he conceived, to hold the following conclusions, which were summed up in these words, to wit:—

1st. A latent power of hybridity exists in many animals in the wild state; in which state also hybrids are produced.

2d. Hybridity occurs not only among different species, but among different genera, and the cross-breeds have been prolific in both cases.

3d. Domestication does not cause this quality, but only evolves it.

4th. The capacity for fertile hybridity, *cæteris paribus*, exists in animals in proportion to their aptitude for domesticity and cultivation.

5th. Since various different species are capable of producing together prolific hybrid offspring, hybridity ceases to be a test of specific affiliation.

6th. Consequently, the mere fact that the several races of mankind produce with each other a more or less prolific progeny, constitutes in itself no proof of the unity of the human species.

You see here what pains were taken by him to learn the facts in relation to hybridity in general, and to bring those facts to the decision of the question, as applied to the races and families of mankind! What a careful and pains-taking man he was; how conscientious as to the sacredness of truth, and how pure minded in the love of it!

Still, I am pained to say, these conclusions were attacked and controverted with such asperity, in different quarters, as to grieve him on account of the misconceptions that arose as to his inferences, and to prompt him to further inquiries and publications with which you are acquainted.

It seems to me probable that these attacks upon him would have been avoided but for the absence in science of any clear and unequivocal idea or competent definition, of the word *species*, with power to apply the term unerringly.

Dr. Morton says, at page 4 of the Essay on Hybridity, that, "where races can be proved to possess certain primordial distinctions which have been transmitted unbroken, they should be regarded as true species." But the impossibility of applying this test to the whole immense catalogue must make it often unavailable for the objects whether of classification or other philosophical deduction.

It may be said that there is nothing in nature so unchangeable as a species, which by a distinguished philosopher, M. Flourens, has been pronounced to be *un être collectif*, a collective being; *l'unité de la nature, impérissable en totalité*, the unity of nature, imperishable as to its totality; except in those cases where some overwhelming cataclysm comes to engulf a whole species and overturn the whole immutable order of the universe.—*Flourens, Cours sur la générat., l'ovologie, et l'embryologie.*

I should gladly present to you here the views of illustrious persons upon the nature and powers of species, did time allow. As it is, I may only say that Morton has himself given a definition of species, which is fit to be passed throughout the republic of letters as his own, and which has been beautifully complimented in a very high quarter. That definition of species is in these words,

"Species, a primordial organic form."

There is contained, among your archives, the letter to him from one of the most illustrious of living naturalists, which contains the beautiful compliment to which I allude.

Dr. Morton having made use of the so-called test of hybridity for the enlightenment of his own judgment, could not believe it applicable to settle the questions arising out of the ethnological differences of our race, and he merely announced that result—he had a good right to do so, if he spoke what he believed to be the truth upon a question in physics.

I beg you to understand that I am not called upon here to defend Dr. Morton, in his views of the great question whether the diversities, detected and figured by him, of craniological form, capacity, etc. etc., and which he insists are perennial, reaching down from the dates of the oldest human records and exuviæ, shortly subsequent to the subsidence of the flood, to the present time, be or be not sufficient grounds for his opinion. I leave these questions to the learned.

But may I not remark that the opposition to him and them probably arose more from some vague indeterminate apprehension, that they might be used as levers to disturb our faith in the Sacred Writings, than because they conflicted with inferences drawn by the highest authority in science, as Buffon, Cuvier, Flourens, Prichard and others, who, regarding species as unalterable, could not discern in the immense varieties of the human race, as to form, intelligence, color, and even endowment with organs, valid objections to the unity?

I trust I may further say I am quite sure the idea of disturbing any man's religious faith was foreign to his good heart, and, indeed, that neither his own religious tranquillity, nor that of his opponents was ever in the least shaken by the doctrine of the geographical distribution of plants and animals.

That distribution, as a primordial constitution of them, whether examined as palæontological or as living species, is the inevitable conclusion of the mind; but the doctrine might, by some persons, be held as erroneous and offensive as that of the plural origin of man.

He conscientiously believed that the anthropology of the Scriptures ought not to, and does not, conflict with the notion of a plural origin of the race or races, which in nowise disclaims the unity of mankind as identical in species, and as brothers in moral and in physical nature, responsibility and destiny, power, hope, and free-will. * * * *

He did believe that he spoke the truth; and that truth, which is never irreconcilable with God's will and purpose, admits of being spoken and ought not to be hid. In this spirit, if this was his spirit, even though he erred, he was surely no conspirator.

I shall dismiss this part of my subject when I shall have presented to you a passage from that celebrated writer, the Chevalier Bunsen, showing *his* views upon a subject connected with the topic under review.

In his ***Egypt's Place in the World's History***, the Chevalier Bunsen asks whether the study of Egyptian History would lead us to a conclusion that there was one universal deluge, or several partial and local floods; and whether the most ancient traditions, those of Egypt especially, exhibit any indications of violent interruptions in the early stages of human advancement; and lastly, what light is thrown by "our researches" on the great question of the unity of the human race and its primordial epochs.

"No historian," says he, "in these days, who deals honestly and conscientiously with Egyptian chronology, can evade these questions. We have no hesitation in asserting at once, and without entering into any further investigation, that there exist Egyptian monuments, the date of which can be accurately fixed, of a higher antiquity than those of any other nation known in history, viz., above 5000 years. The fact must be explained: to deny it would be a proof of little skill and still less candor on the part of any critic who has once undertaken to make the investigation."

Time bids me bring this memoir to a conclusion.

On the 3d of December, 1848, Dr. Morton was seized with pleuro-pneumonia of the left lung, which brought his life into imminent peril, at the time, but, after a severe and protracted struggle, left him to come forth again upon the stage of action a man in broken health from a ruined lung.

It was supposed he could never again engage in the pursuits of his profession; yet his indomitable courage and industry drove him into a still busier round of occupations, which increasing favor brought to him. After his illness he never breathed, save by the right lung alone.

Many of his medical friends exhorted him to spare a frame supported on such frail props of strength, by lessening his labor as physician; and they clearly indicated the premature dissolution that must follow any such course of exertions as his.

He was as well aware as the most sagacious of them of these risks; but he could not consent to live useless in the world, and so he labored diligently in his calling, and always, even in his illness, loved and remembered the Academy.

It was on Saturday the 10th of May, 1851, that, having spent the evening in the usual happy intercourse with his family, he was seized, towards the close of the evening, with a slight headache, which became violent on the following day, Sunday, the 11th, during which day he had also pain in the back and limbs. After having suffered severely from these symptoms, and from sleeplessness, he found himself on the morning of Wednesday, as he believed and said, free from disease, so that he slept tranquilly for several hours.

He now entered cheerfully into the affairs of his family, giving lively attention to the business of his household until, made happy by improving health, he sunk into a calm sleep.

He awoke in about an hour, and alarmed his friends by unmistakable evidences of great hebetude of the perceptive faculties, but expressed himself as free from pain. He was yet disposed to sleep, as soon as his attention ceased to be called. Very soon the power of deglutition was lost, hemiplegia of the right side was added to the mortal train, and he passed into profound coma, which terminated his existence at noon on Thursday, the 15th of May, 1851, in the 52d year of his age.

Dr. Morton was united in marriage to Rebecca, daughter of Robert and Elizabeth Pearsall, of this city, on the 23d Oct., 1827.

His home thenceforth was the secure abode of domestic peace, unity, and concord; and the happiness of that charming intellectual circle was broken only when disease or death could burst through the sacred spell of love and hope that bound, as in a protecting zone, its sweet repose.

It is proper to draw a veil over grief too sincere and too great to find consolation, save in religious confidence and hope. Nor should I take the occasion of this memoir even to make mention of a deep affliction he had in the loss of a noble youth, most hopeful and promising, who was cut off by death on the 15th May, 1850. Yet I venture to allude to it here that I may exhibit a specimen of his versification that shows, as well as many others

I have perused, not merely the intensity of his parental feeling, but also the graceful form in which he was ofttimes accustomed to express his sentiments in verse.

A Father's lament for his Son, George Morton, born December 21, 1832—
Died May, 15, 1850.

"Stretched on the couch of anguish, lay
A youth, of manly form and graceful brow;
But lo! the strength of yesterday
Gives place to weakness now:
A day of agony—an hour of rest—
Then came the pulseless hand, and heaving breast,
And all was over. O! that sacred spell!
Wherein we prayed, and wept, and bade farewell!
That hurried warning of eternity!
That gush of wild emotions! O! my child!
Yet, thou alone wert calm and reconciled;
Death brought no fears to thee.
And art thou gone forever? Thou who seemed
An angel in my house and heart:
So young, so pure, so bright! I had not dreamed
That thus untimely we were doomed to part,
Or I should live to see the wild flowers bloom
Around thy early tomb.
Thy joyous step no more
Is heard by those who welcomed it before.
The sounding viol and the cheerful flute
By thee no longer touched, are hushed and mute;
And all is lone and sad where thou hast been;
Thy voice unheard—thyself unseen.
Yet, in our hearts thy memory shall live
Embalmed and beautiful, till life is o'er;
And then the promise of our faith shall give
Thy spirit back to us, to part no more
In that mysterious clime,
Where takes the soul no note of toil or time.

Thy tranquil grave is by the river's side,
And there our dust shall mingle with thy own;
And we will pray to die as thou hast died,
And go where thou art gone."

And alas! gentlemen, exactly one year after the loss of his beloved son, the good physician's grief was over, and the dust of the father and the child are mingled on the banks of the Schuylkill, at Laurel Hill.

His touching expressions reveal the truth of Morton's feelings; for he was a man of truth, and altogether above that sickly sentimentality that pours forth, in prose or in verse, expressions of passion never keenly felt, or grief never earnestly brought home to the life and the affections.

A volume of verses in manuscript lies before me, from which however, I shall not select any other specimens.

At his death, he left with his widow five sons and two daughters, who deplore the loss of a tender husband and parent, than whom I have not known one more excellent and amiable.

I have already said that his love for his family was almost idolatrous, and many of us who are witnesses of the graceful and unaffected hospitality of his house, can testify as to the marks of his love and confidence towards them: and we must, with one accord, regret the dissolution of those pleasant reunions, in which we have participated there, with men of letters and science of our own country or from foreign nations, who, with us, observed the cordiality and simplicity of his manners, in which were joined, in just proportions, dignity and urbanity.

Dr. Morton was a man above the ordinary stature; his face was oval, and always pale; his eyes a clear bluish-gray; his hair light.

As a man, he was modest in his demeanor, of no arrogant pretensions, and of a forgiving temper; charitable and respectful to others, yet never forgetful of self-respect. That he was a religious man I know from many opportunities had with him, and from his life and conversation. He was always in earnest and always to be depended upon.

Few men are to be found more free from faults, and few of greater probity or of more liberal sentiments, or of purer designs and aspirations. Doubtless he had faults, but they were not obvious, and I never discovered them in an acquaintance of near thirty years with him.

I have endeavored, while speaking of my friend, and while expressing my thoughts of what he was and what he performed, not to transcend the bounds of truth as to his character and his actions. I willingly give praise to all such Scholars; for I regard all men like him as fit teachers and guides for mankind.

Dr. Morton had the honor to be elected member of many societies of the learned in various parts of the United States, in Europe, and in the East, among which were the following:—

The Academy of Natural Sciences of Philadelphia. The Philadelphia Medical Society. The College of Physicians of Philadelphia. The American Philosophical Society. The United States Medical Association. The Massachusetts Medical Society. The Western Academy of Natural Sciences at St. Louis, Mo. The Georgia Historical Society. The Lyceum of Natural History of New York. The Boston Society of Natural History. The American Oriental Society at Boston. The American Ethnological Society at New York. The Medical Society of Sweden. The Royal Botanical Society of Ratisbon. The Academy of Science and Letters at Palermo. The Royal Society of Northern Antiquaries at Copenhagen. The Academy of Science, Letters, and Arts de Zelanti di Arci-reale. The Imperial Society of Naturalists of Moscow. The Medical Society of Edinburgh. The Senckenburg Natural History Society of Frankfort-on-Mayne.

The following are the titles of the published works of Dr. Morton, after which I have placed a translation of a letter addressed to him by the Baron Humboldt. [The list of his papers in different Journals, we propose to give in another place.—Eds.]

Synopsis of the Organic Remains of the Cretaceous Group of the United States, 88 pp. 8vo. With 19 plates. Philadelphia, 1834.

Illustrations of Pulmonary Consumption, its Anatomical Character, Causes, Symptoms and Treatment, with 12 colored plates: Philadelphia, 1834.

Mackintosh's Practice of Physic, with Notes by S. G. Morton.

Crania Americana; or, a Comparative view of the Skulls of various Aboriginal Nations of North and South America: to which is prefixed an Essay on the Varieties of the Human Species; illustrated by seventy-eight plates, and a colored map, by Samuel George Morton, M.D., &c. &c., folio: Philadelphia and London, 1839.

Inquiry into the Distinctive Characteristics of the Aboriginal race of America: 2d edit., 1844.

Crania Ægyptiaca; or, Observations on Egyptian Ethnography, derived from History and the Monuments; plates and wood-cuts: Philadelphia and London, 4to, 1845.

An Illustrated System of Human Anatomy, Special, General, and Microscopic: Philadelphia, 8vo, 1849.

Biographical Notice of the late George McClellan, M.D.: read before the Philadelphia College of Physicians, Sept. 4, 1849.

Translated copy of a Letter from Baron Alexander Humboldt to S. G. Morton, M.D.

Sir:—The close bonds of interest and affection that have for the past half century connected me with the hemisphere in which you reside, and of which I flatter myself that I am a citizen, have added to the impressions made upon me by the receipt, almost at the same moment, of your great work on Philosophical Physiology, and the admirable *History of the Conquest of Mexico* by Mr. Wm. Prescott. Works of this class, which extend by very different means the sphere of our knowledge, serve to add to the glory of one's country. I cannot sufficiently express my deep gratitude to you.

At my advanced age, I am peculiarly gratified by the interest still preserved for me beyond the great Atlantic valley over which a bridge has, as it were, been thrown by the power of steam.

The craniological treasures which you have been so fortunate as to unite in your collection, have in you found a worthy interpreter. Your work is equally remarkable for the profundity of its anatomical views, the numerical detail of the relations of organic conformation, the absence of those poetical reveries which are as the myths of modern physiology, and the generalizations with which your Introductory Essay abounds.

Being at present occupied in the preparation of the most important of my works, which will be published under the imprudent title of *Cosmos,* I shall know how to profit by so many excellent views upon the distribution of the races of mankind that are scattered throughout your beautiful volume. One cannot, indeed, but be surprised to see in it such evidences of artistic perfection, and that you could produce a work that is a fitting rival of whatever most beautiful has been produced either in France or in England. I pray you to accept the renewed expression of the high consideration with which I have the honor to be, sir, your obedient, humble servant,

ALEXANDER HUMBOLDT.

Berlin, 17th January, 1844.

Art. XIII.—*An Excursion on Etna;* by B. Silliman, Jr.

It was nine o'clock at night when we were summoned by our guide "Matteo" to mount our mules and follow his lead toward the great Cone of Mount Etna. We had prepared ourselves with suitable clothing for protection against the cold which we must encounter on the snow. My own dress was that of our American winter, besides which we were provided with warm woollen leggings of coarse yarn drawn over our boots and pantaloons above our knees. We had common gloves and over these thick woollen ones. Two shirts and a comforter for the neck, with an Italian Capote for the head completed our equipment. The ascent of the cone is seldom attempted so early in the season.

The sun had set in cloudless splendor, and as it rose on the morning of the same day, the summit of Etna was gilded with his earliest rays. Not a breath of wind was abroad. All the favoring circumstances gave us every reason to hope that our labor would not be in vain, and very naturally put us in good spirits for the wearying ride which was before us.

Besides "Matteo" we had also "Antonio," another experienced guide, judging it unsafe from the possibility of accidents to go up with one man only. Our party was therefore four men altogether, Mr. Brush and myself riding between the two guides. The night, as I have said, was serene, the stars shone in great brilliancy, and although there was no moon, we were soon able to see our way with sufficient clearness to inspire confidence. Our former experience with the mules had taught us that it was worse than useless to attempt to guide them, and that all we had to do was to sit still and let them follow the leader which they did with unerring step, seeming as if by instinct or by eyes in their shoes, to avoid every loose stone, and choose the securest foothold.

Our path lay for nearly or quite two hours over an unbroken waste of ancient lava, unwooded and with not a plant or vine to mark our course. This field we had not before traversed as our former excursions had taken us by other paths and away from this route leading towards the summit. On coming down in the morning we saw it of course with more distinctness and shall speak of it again. This tract bounds the fertile zone of vines and figs, although from the barren nature of the ancient lava at *this part of* the fertile district there is rather the appearance of a vast desert. Emerging from our stony path at the upper edge of the old lava, we suddenly entered the wooded zone, the commencement of which is as definite as the entrance to a cultivated park from a dusty road. This zone is one of the peculiar and most beautiful features of Etna, and demands especial notice by day. As we wound along our zigzag path slowly and cautiously, all we could discern was the shadowy form of huge trees widely planted, while the voice of a night songster told us of life and enjoyment in the vast solitude. We could tell also that the feet of our mules were treading soft sand, and the deeply worn path sometimes brought our feet in contact with the green sward. Mr. Brush and I had kept up a brisk conversation all the way, and the time past cheerfully and fast. We could hold no intercourse with our guides, who spoke only Italian; nevertheless we managed to make them understand nearly all that we had occasion to ask. About twelve o'clock we came upon a little hut where our guides dismounted and motioning to us to do the same, we found it was their purpose to feed the animals, which example we also followed by a resort to our provision basket. Near our halting station was an immense tree under which we found an agreeable resting place—it measured about twelve feet in circumference. It was obvious from the glimpses we had obtained of the country below that we had risen to a great altitude, while the decreasing number of trees indicated our approach to the termination of the wooded zone. Before us the hills rose more rapidly, and we could also dimly discern occasionally a cinder cone. The air was sensibly cooler, and to our disappointment the wind had already risen to an uncomfortable breeze, which made it necessary to button up our coats and tie on our comforters. The mules being fed, we were again on our way, and in about twenty minutes, saw the last of the trees. An owl in a neighboring wood below us on the side of an ancient cone bade us farewell in a melancholy hoot, and we entered immediately on the desert zone. Our path at once became very rough and precipitous, now requiring us to grasp the mane of the mule, and the next to throw all our weight back to avoid sliding over his neck. But the patient, cautious creatures toiled on, pausing occasionally for an instant as if to reassure themselves, and then carefully advancing. Our guide too excited constant wonder. It was impossible to see a path—immense gulfs of rugged lava surrounded us; we found ourselves standing on the brink of precipices over which the course seemed to lead us, but a sudden turn carried us away just as the sense of danger was coming over us. There were to us no visible landmarks, and on every side in the dim distance of night we saw only an unending sameness of lava currents, ridges, gulfs, billows, and windings. Left to ourselves, we should certainly have given up in despair and waited the dawn; yet the guide was never for an instant at a a loss: not a word was spoken; our brisk conversation had died away in silence, and each seemed sufficiently occupied with the scene about us—for it was awfully sublime; and a thought of personal safety would perhaps occasionally present itself. Above us the snowy head of Etna floated like a cloud against the dark blue sky, and the constellations moved with our ascent, rising or falling as if with a more rapid revolution of the earth. The Great Bear was immediately before us, and every instant as we rose it sank until we soon hid from view the lower stars behind the cone of the volcano. It was now very cold, and we could distinctly trace at no great distance from us the snow in the deep gulleys of the mountain like white streamers from the great mass above. A few minutes brought us upon the lower patches, and from that instant the naked black rocks began to disappear, being replaced by the glistening snow. Our guide had several times shouted in a peculiar tone toward the west as if to arouse the echoes of the mountain. To our surprise his call wás answered, and we were in some amazement to guess who should be in that lonely spot at such an hour to return his salutation. The enigma was soon explained by the appearance of another guide to take charge of the mules. We had now reached the limits of our riding—we had been five hours in the saddle, and were now on the present confines of the snow. We dismounted, refreshed ourselves with some hard eggs and wine, took our mountain staffs and followed the guides who struck out immediately upon the snow. The wind now blew fiercely from the N. W., an ominous cloud was in the east, a heavy haze hung over the island, and I told Mr. Brush of my fears that we had no bright sunrise awaiting us. Still large portions of the sky were clear, and we had good courage to go on. I pointed Matteo to the cloud, when I found he had my fears; for he shook his head and said despondingly, looking to the cone, "molto vento." The ascent on the snow for the first mile or two was at an easy angle. The snow was crystallized like ice freshly broken, and soft enough to give us a firm foot-hold.

It was about quarter past two when we made our first halt at the pillar of stone erected at the base of the minor peak of Etna, which is called "Montagnuola." While stopping here over our basket of provisions, we observed in a striking manner the deceptive nature of distance, where objects are viewed from a great height and especially at night. We saw two lights, one of which we supposed to be the man with the mules (who had no light!) and the other we did not so clearly make out. On enquiry of Matteo, he told us that one (the first) was a light-house on the coast at Catania—twenty-five miles off—the other, the signal at Bronte, an equal distance on the opposite side of the mountain. Never was I so deceived by a physical phenomenon; I could have answered with the greatest confidence that both lights were within hailing distance. We now turned our course more northerly, the angle of ascent increased, and our exertions were arduous. We saw, as we thought, the ridge of the mountain just before us however, and over it the naked cone of Etna rising like an immense dome from the snowy waste. We pushed on to gain the ridge, and as it faded away another more distant presented itself. We looked back on the path we had come and forward, in hopes that the comparison would encourage us by showing that we had passed over the longer distance. No such comfortable assurance however was ours, and we would throw ourselves flat on our backs on the snow to regain freedom of respiration, and then push on anew. The wind was now fiercely keen, and so powerful, that had it been in our faces, I am persuaded we could not have made the ascent. Fortunately it was on one side, but it brought up frightful banks of clouds, while the wind cloud in the east had grown into massive banks of a dull grey, which hung directly over, where the first light of the morning indicated the position of the rising sun.

Our prospects were bad, and worst of all the apex of the cone was now invisible, while heavy masses of white vapor were constantly precipitated on it from the fresh portions of air which the wind brought in contact with the whole mountain side. We gained the "Casa Inglese," English house, just before four o'clock and were glad to find a shelter from the fierce wind under its gable—the only portion which was not buried in the snow. There was the cone immediately before us and at our feet—should we go up? pride said "yes"—discretion and the guide said "no." If the wind at the base would hardly allow us to keep our feet, what would it be on the unprotected summit 1300 feet higher? We concluded to wait for if we left our present position and gained the clouds we should not see the sun rise at all, nor any thing else. The whole horizon over Catania and Calabria was so hung with mist that we could see nothing distinctly. So we had no alternative but to wait where we were, in the hope that the rising sun would dispel the clouds and vapors and then ascend. At 4^h 25^m the sun appeared. It was a glorious sight. The dull clouds over the horizon were of a lovely purple and gold while a faint rosy light tinged the wastes of snow about us with an illusive warmth. But the glory was transient, the envious clouds shrouded his too brilliant glories, while the mists over Etna seemed every instant to thicken. We tried the temperature of the air and snow and found it to be $-7°$ C. $=20°$ F. At Catania on Thursday it had been 94° We had in fact, by an ascent of 9500 feet, made a difference of near 70° of temperature in a few hours.

There was therefore no alternative, we must abandon the idea of ascending the cone—it was useless and a mere waste of time and strength. Our guide, whose experience was great, decidedly opposed it and so we turned to see the *Val del Bove* from above. We had explored this vast gulf from below and were desirous of seeing what proportion it bore to the general surface of Etna. This we had hoped to do from above on the upper cone—the next best thing was to see it from the verge of the bounding precipice. Our path lay before the wind which was so violent that it was easy to keep up a full run and the loose snow kicked up by our feet was driven before us quite like a snow storm. It was near a mile to the edge of the precipice. I had been advised by Dr. Gemmellaro to keep my eyes shut until the guide placed me in a position to see the gulf and then to look in suddenly—as the best way to obtain a vivid impression. This I did: on raising my eyes, a scene of awful grandeur was before me, and the story it told was as plain in the history of past changes in the mountain as in a written record of human action. From this point the Val del Bove was somewhat quadrangular in form and even more grand in its ruins than when seen on its bare plain. Here was a yawning chasm so deep and so wide that Vesuvius might be set down in it and have room to spare on either side, while its summit cone would hardly reach up to our feet! Vast indeed was the engulfment which had swallowed up so wide an area—and yet how small was that area compared with the whole surface on the flanks of this grand dome. In this view the remark of Spallanzani seems just, that compared to Etna, Vesuvius was a cabinet volcano.

The position of the sun, as it shone in our eyes, was not favorable for a good view of the valley; yet under the disadvantages, its bold crags, sharp wall-like dykes projecting from the sides, with a frigid yet tumultuous ocean of lava currents below us, were remarkably grand and impressive. "Capra" and "Musara" stand like sole remaining sentinels of the conflict in the midst of the scene; and in the distance lay the Mediterranean with black rivers of lava leading the eye to it:—all these and many other minor elements of grandeur combine to render it one of the most impressive and powerfully instructive scenes which it is possible to behold.

From the Val del Bove we turned our steps down the mountain in the general direction in which we had ascended. And now in the bright light of day, the weary wastes of unbroken snow seemed more extensive than on our ascent. We had been nearly or quite six miles over the snow but it was in the dark and we could not see its extent. Now on every side, we saw only an arctic winter, while below us, and almost in sight, were standing fields with vines, figs and olives, lemons, besides grain all yellow to the harvest. It was about 6½ when we at last reached our mules and took our *breakfast.* The descent we found more arduous than the ascent, not only because we were fatigued, but also on account of the great strain on the knees in holding back against the stirrup. As we went down the contrast of temperature again struck us very much. Our Etna clothing became oppressive, and one by one we cast off all our superfluous garments. On entering the wooded region we were enchanted with its beauty, although, as Dr. Gemmellaro assured us, it has been greatly injured of late years by the cutting away of some of the best trees. The wood is mostly oak with a few pines and firs; the trees are very large, not high, and at such distances from each other that they seem to have been planted by art as in a park. But the most beautiful feature of this region are the ancient cones whose slopes are grassed and also wooded. They retain perfectly their form, inside and out; the trees upon them are not thick enough to hide their forms while they give life and beauty in a surprising manner. These trees were completely vocal with birds as we rode through, but we recognized no familiar faces among the songsters. This morning we were too soon through the beautiful zone of the trees, especially as succeeding them was a very long and tedious ride along the descent of the old lavas before named, before we could reach the village of Nicolosi.

It was excessively hot, mules and men were all thoroughly fagged, and I noticed as we rode along that our guide slept quite continuously on his mule. For myself I had not the least feeling of sleepiness. It was 9¾ A. M. before we reached the hotel, quite to the surprise of all, who were not looking for us until eleven o'clock. They were all amazed to hear of the wind we had experienced on the mountain, as it had been perfectly calm below, and they had thought we were entirely successful in our ascent. Yet unsuccessful as we certainly were in not reaching the summit, we had enough to repay us for the toil and exposure. The spirit of adventure alone is sufficient to satisfy most people who have confined their mountain rambles to the day. The snow also in its extent and massiveness entirely exceeded any expectations I had formed of it; and, above all, the Val del Bove, had we seen nothing else, would have rewarded us for the labor we had undergone. It is not merely for a sight of the rising sun that it is worth while to ascend in the night. The distance is such that the time consumed is necessarily from twelve to fifteen hours, and to do all this under a bright sun is a great exposure of health. It is far safer to descend from the climate of mid-winter to summer, than heated and moist with perspiration to plunge from summer into winter. The effect of a full sun also on the snow as reflected in the eyes is too much for the unprotected vision with the brilliant splendor of an Italian atmosphere. I think it then a wise course to go up at night, and no one need fear being overcome with sleep; the excitement of the occasion is too great. In summer, that is in July or August, the English house is free from snow, and then adventurers may carry up their mattresses and sleep there. This reduces the labor very much, since when the snow is off, mules may go quite to the Casa Inglese; and then the adventurer may engage with comfort and strength in his explorations. Dr. Gemmellaro has a plan for reconstructing the English house in the form of a pyramid, and in such a manner that access may be had to it in even the winter by an opening near the summit. The distance from Nicolosi to the summit of the cone is estimated by the guides at twenty-four miles, but Dr. Gemmellaro thinks it only fifteen.

Nicolosi, May 30th, 1851.

Art. XIV.—*On Coral Reefs and Islands;* by James D. Dana. Part Sixth.

4. *Origin of the Channels within Barriers, and of the Atoll Form of Coral Islands.*

In the review of causes modifying the forms of reefs, no reason was assigned for the most striking, we may say the most surprising, of all their features,—that they so frequently take a belt-like form, and enclose a wide lagoon; or in other cases, range along, at a distance of some miles, it may be, from the land they protect, with a deep sea separating them from the shores.

This peculiar character of the coral island was naturally the wonder of early voyagers, and the source of many speculations. The instinct of the polyp was made by some the subject of special admiration; for the "helpless animalcules" were supposed to have selected the very form best calculated to withstand the violence of the waves, and apparently with direct reference to the mighty forces which were to attack the rising battlements. They had thrown up a breastwork, as a shelter to an extensive working ground under its lee, "where their infant colonies might be safely sent forth."*

It has been a more popular theory that the coral structures were built upon the summits of volcanoes;—that the crater of the volcano corresponded to the lagoon, and the rim to the belt of land; that the entrance to the lagoon was over a break in the crater, a common result of an eruption. This view was apparently supported by the volcanic character of the high islands in the same seas.—But since a more satisfactory explanation has been offered by Mr. Darwin, numerous objections to this hypothesis have become apparent.

a. The volcanic cones must either have been subaerial and were afterwards sunk beneath the waters, or else they were submarine from the first. In the former case the crater would have been destroyed, with rare exceptions, during the subsidence; and in the latter there is reason to believe that a distinct crater would seldom, if ever, be formed.

b. The hypothesis, moreover, requires that the ocean's bed should have been thickly planted with craters—seventy in a single archipelago,—and they should have been of nearly the same elevation; for if more than twenty fathoms below the surface, corals could not grow upon them. But no records warrant the supposition that such a volcanic area ever existed. The volcanoes of the Andes differ from one to ten thousand feet in altitude, and scarcely two cones throughout the world are as nearly of the

* Flinders.

same height as here supposed. Mount Loa and Mount Kea, of Hawaii, present a remarkable instance of approximation, as they differ but two hundred feet: but the two sides of the crater of Mount Loa differ three hundred and fourteen feet in height. Mount Kea, though of volcanic character, has no large crater at top. Hualalai, the third mountain of Hawaii, is 4000 feet lower than Mount Loa. The volcanic summit of East Maui is 10,000 feet high, and is a fine example of a large crater; but the wall of the crater on one side is 700 feet lower than the highest point of the mountain; and the bottom of the crater is 2000 feet below the rim of the crater. Similar facts are presented by all volcanic regions.

c. It further requires that there should be craters at least fifty miles in diameter, and that twenty and thirty miles should be a common size. Facts give no support to such an assumption.

d. It supposes that the high islands of the Pacific, in the vicinity of the coral islands, abound in craters; while on the contrary there are none, as far as is known, in the Marquesas, Gambier, or Society Groups, the three which lie nearest to the Paumotus. Even this supposition fails, therefore, of giving plausibility to the crater hypothesis.

Thus at variance with facts, the theory has lost favor, and is no longer sustained even by those who were once its strongest advocates. The question still recurs with regard to the basement of coral islands, and the origin of their lagoon character. Shall we suppose, with some writers, that these islands were planted upon submarine banks, within one hundred and fifty feet of the surface of the sea? As has been said, there is no authority for the supposition. We nowhere find regions upon our continents with elevations so uniform in height; and submerged banks of this kind are of extremely rare occurrence. If such patches of submerged land existed, the lagoon structure would still be as inexplicable as ever; for the growing reefs of the Pacific show that corals may flourish alike over all parts of the bank, where not too deep. The zoophyte can by no means be said to prefer the declivity to the central plateau of the submarine bank: on the contrary, the part nearest the surface appears to abound in the largest species of corals.*

A study and comparison of the reefs of different kinds,—fringing, barrier, and atoll,—throughout the oceans, is the only philosophical mode of arriving at any conclusion on this subject. This course Mr. Darwin has happily and successfully pursued, and has arrived, as we have reason to believe, at the true theory of Coral Islands. It is satisfactory, because it is a simple generali-

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* Lieutenant Nelson, R. N., suggested this hypothesis before the publication of Mr. Darwin's views. See Geol. Trans., vol. v, 12; and Darwin, op. cit., p. 94.

zation of facts. The explorations of the Expedition afford striking illustrations of his views, and elucidate some points which were still deemed obscure, establishing the theory on a firm basis of evidence, and exhibiting its complete correspondence with observation.

A. *Channels within barriers.*—We may turn again to the chart of the Feejee Group, and glance successively at the islands Goro, Angau, Nairai, Lakemba, Argo Reef, Exploring Isles, and Nanuku.* In Goro, the reef closely encircles the land upon whose submarine shores it was built up. In the island next mentioned, the reef has the same character, but is more distant from the shores, forming what has been termed a barrier reef; the name implying a difference in position, but none in mode of formation. In the last of the islands enumerated, the barrier reef includes a large sea, and the island it encloses is but a rocky peak within this sea.

Can we account for this diversity in the position of barrier reefs, and in their extent as compared with the enclosed land? There is evidently one way in which these features might have been produced. If, for example, such an island as Angau were very gradually to subside, from some subterranean cause, two results would take place:—the land would slowly disappear, while the coral reef, which is ever in constant increase, as has been explained, might retain itself at the surface, if the rapidity of subsidence was not beyond a certain rate. This subsidence might go on till the last mountain peak remained alone above the waters. Should we not then have a Nanuku? Suppose the subsidence not to have proceeded quite as far as this, it might leave only a single ridge and a few isolated summits peering above the waves. Would not its condition in this case be that of the Exploring Isles? On such a supposition, reefs of large size encircling a mere point of rock might be explained in every feature. The subsidence of Goro, on the same principle, would produce an Angau, or, carried further, a Nanuku.

It may here be remarked, that the fact that changes of level in the earth's surface have taken place over vast areas, is fully proved, and accounts of some of them which are now in progress, as that of Sweden, are to be found in any geological treatise.

But it admits of direct demonstration that such a subsidence has actually taken place. It has been stated that the depth of the reef at different distances from the shore it encircles may generally be estimated from the slope of the shore. On this principle it has been shown† that the thickness of the distant barrier reef cannot be less in some instances than a thousand feet; and

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* This chart will be found in copies of the Narrative of the U. S. Exploring Expedition, by Capt. Wilkes, U. S. N.

† This Journal, [2], vol. xi, p. 371.

in many cases it is probably much greater. Now as reef corals do not grow below twenty fathoms, there is no way in which this thousand feet of reef could have been formed except by a gradual subsiding of the land upon which it stands. The large number of instances of distant barriers in the Pacific remove any doubt with regard to these conclusions. The map of the Feejees abounds in them through its eastern part, and we may infer with reason that this has been a large area of subsidence, like that which is now going on in Greenland.

Evidence of subsidence still more conclusive, if possible, is obtained by actual observation at Metia and some of the elevated coral islands. This island is 250 feet in height, full twice the coral-growing depth. At another island in the Hervey Group, Mangaia, the coral rock is raised 300 feet out of water.

The fact of subsidence having actually taken place during the formation of many reefs, is therefore put beyond doubt. It must form a part of any true theory of reefs, whether it be the crater hypothesis or the view here advocated. The latter has this advantage, that it explains all the facts, and requires no other element but this single one of subsidence. It rests on a simple fact and demands no hypothesis whatever.

The manner in which subsidence would operate is shown in the following sketches, representing ideal transverse sections of an island and its reefs. In figure 1, if I be the water line, the island, like Goro, has a simple fringing reef, *f*, *f*:—it is a narrow platform of rock at the surface, dropping off at its edge to shallow depths, and then some distance out, declining more abruptly. Let the same island become submerged till II is the water line:—the reef extends itself upward, as submergence goes on, and may have the character at the surface represented by $b' f' b' f'$. There is here a fringing reef and also a barrier reef, with a narrow channel between, such as we have described as existing on the shores of Tahiti;* b' is a section of the barrier, c' of the channel, and f' of the fringing reef. Suppose a farther submergence, till III is the water line: then the channel ($c'' c''$) within the barrier is quite broad, as in the island of Nairai or Angau; on one side (f'') the fringing reef remains, but on the other it has disappeared, owing, perhaps, to some change of circumstance as regards currents, which retarded its growth, and prevented its keeping pace with the subsidence. With the water at IV, there are two islets of rock in a wide lagoon, along with other islets ($i''' i'''$) of reef over two peaks which have disappeared. The coral reef-rock by gradual growth has attained a great thickness, and envelops nearly the whole of the former land. Nanuku, the Argo Reef, and Exploring Isles are here ex-

* This Journal, [2], vol. xi, p. 366.

MAPS AND IDEAL SECTIONS OF CORAL REEFS AND ISLANDS.

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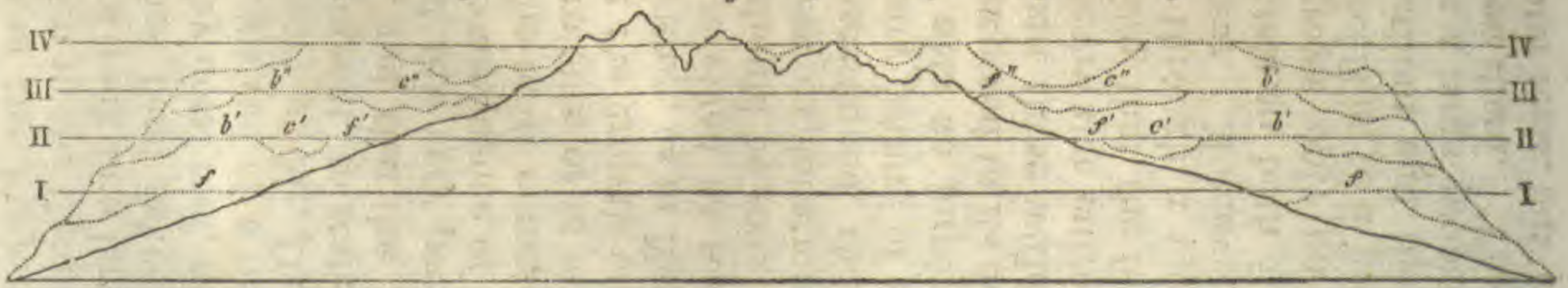

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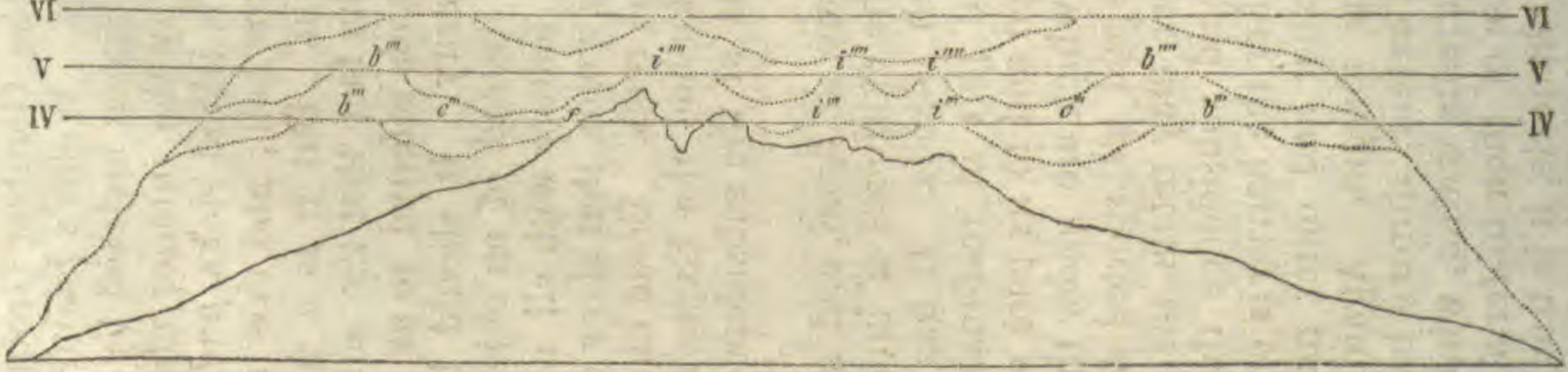
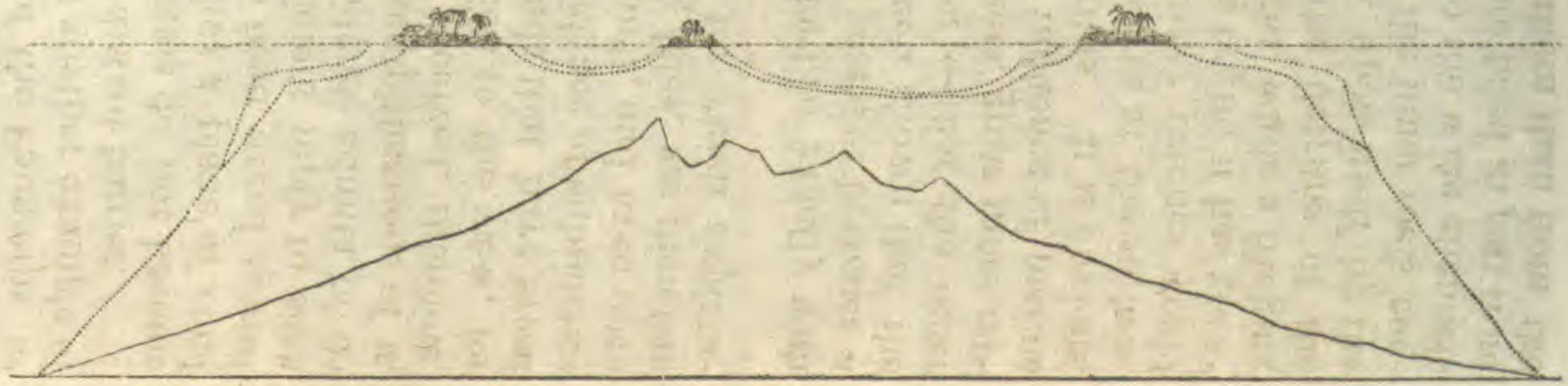


4.

GAMBIER ISLANDS.

6.



emplified, for the view is a good transverse section of either of them. $b''' \, b'''$ are sections of the distant enclosing barrier, and $c''' \, c'''$, and other intermediate spots, the water within.

The supposed similarity between these ideal sections and existing islands is fully sustained by actual comparison. Fig. 2 is a sketch of the island of Aiva in the Feejee Group. There are two peaks in the lagoon precisely as above; and although we have no soundings of the waters in and about it, nor sketches of peaks, facts observed elsewhere authorize in every essential point the transverse section given in figure 3, resembling closely, as is apparent, that in figure 1. The section is made through the line $b \, b$, $b' \, b'$, of figure 2. It is unnecessary to add other illustrations. They may be made out from any of the eastern groups of the Feejees, the Gambier Group of the Paumotus, or Hogoleu in the Carolines. Wallis's Island is another example of islets of rock in a large lagoon inclosed by a distant barrier.

It has been asked why the interior channels do not become filled by coral reef, as the island sinks, and thus a plane of coral result, instead of a narrow belt; and this has been urged against the theory of Mr. Darwin. But it is a sufficient reply to such an argument, to state the fact that the subsidence admits of no doubt, and that the islands referred to as exemplifications of it, present this very peculiarity. It should be received, therefore, as a consequence of it, instead of an objection to the view, for it is the most common feature with all islands that have broad reef-grounds, or in other words, that show evidence of subsidence during the growth of the reefs. Broad channels, and even open seas within, as in Nanuku and the Exploring Isles, are therefore to be received as results of the subsidence, for which explanations should be sought.

These explanations are at hand, and accord so exactly with facts ascertained, that the existence of inner passages becomes a necessary feature of such islands. It has been shown that the ocean acts an important part in reef-making;—that the outer reefs exposed to its action and to its pure waters, grow more rapidly than those within which are under the influence of marine and freshwater currents and transported detritus. It is obvious, therefore, that the former may retain themselves at the surface, when through a too rapid subsidence the inner patches would disappear. Moreover, after the barrier is once begun it has growing corals on both its inner and outer margin, while a fringing reef grows only on one margin. Again, the detritus of the outer reefs is, to a great extent, thrown back upon itself by the sea without and the currents within, while the inner reefs contribute a large proportion of their material to the wide channels between them. These channels, it is true, are filled in part from the outer reefs, but proportionally less from them than from the inner. The extent of reef-grounds within a barrier, raised by accumulations at the same time with the reefs, is often fifty times greater than the area of the barrier itself. Owing to these causes the rate of growth of the barrier may be at least twice more rapid than that of the inner reefs. If the barrier increases twenty feet in height in a century, the inner reef according to this supposition would increase but ten feet; and any rate of subsidence between the two mentioned, would sink the inner reefs more rapidly than they could grow, and cause them to disappear. A wide flat reef, continuous over so extensive reef-grounds, could be formed only with an extremely slow rate of subsidence; and even then they would be liable to be cut up by the production of inner currents, destroying growing corals over the interior parts of the coral reef; so that whatever the rate of subsidence, the inner portions would grow less rapidly. There is therefore not only no objection to the theory from the existence of wide channels and open seas; on the contrary, their non-existence is incompatible with the mode of action going on. They afford the strongest support to the theory.

From these considerations it is evident that a barrier reef indicates very nearly the former limits as to the land enclosed. The Exploring Islets, (Feejee chart,) instead of an area of *six* square miles, the whole extent of the existing land, once covered *three hundred* square miles; and the outline of the former land is indicated by the course of the enclosing reef. A still greater extent may be justly inferred. For the barrier, as subsidence goes on, gradually contracts its area, owing to the fact that the sea bears a great part of the material inward over the reefs: and, consequently, the declivity forming the outer limit of the submarine coral formation, has a steep angle of inclination.

In the same manner it follows that the island Nanuku, instead of *one* square mile, extended once over *two hundred* square miles, or had two hundred times the present area of high land. Bacon's Isles once formed a large triangular island of equal extent, though now but two points of rock remain above the water.

The two large islands in the western part of the group, Vanua Levu and Viti Levu, have distant barriers on the western side. Off the north point of the former, the reef begins to diverge from the coast, and stretches off from the shores till it is twenty and twenty-five miles distant; then, after a narrow interruption, without soundings, the Asaua islands commence in the same line, and sweep around to the reef which unites with the south side of Viti Levu; and tracing the reef along the south and east shores, we find it at last nearly connecting with a reef extending southward from Vanua Levu. Thus these two large islands are nearly encircled in a single belt; and it would be doing no violence to principles or probabilities, to suppose them once to have formed a single island, which subsidence has separated by inundating the low intermediate area. The singular reef of Whippey Harbor, p. 118, is fully explained by the hypothesis. We may thus not only trace out the general form of the land which once occupied this large area, (at least 10,000 square miles,) but may detect some of its prominent capes, as in Wakaia and Direction Island. The present area is not far from 4,500 square miles.

The whole Feejee Group, exclusive of coral islets, includes an area of about 5,500 square miles of dry land; while, at the period when the coral commenced to grow, there was, at least, as the facts show, 15,000 square miles of land, or nearly three times the present extent of surface.

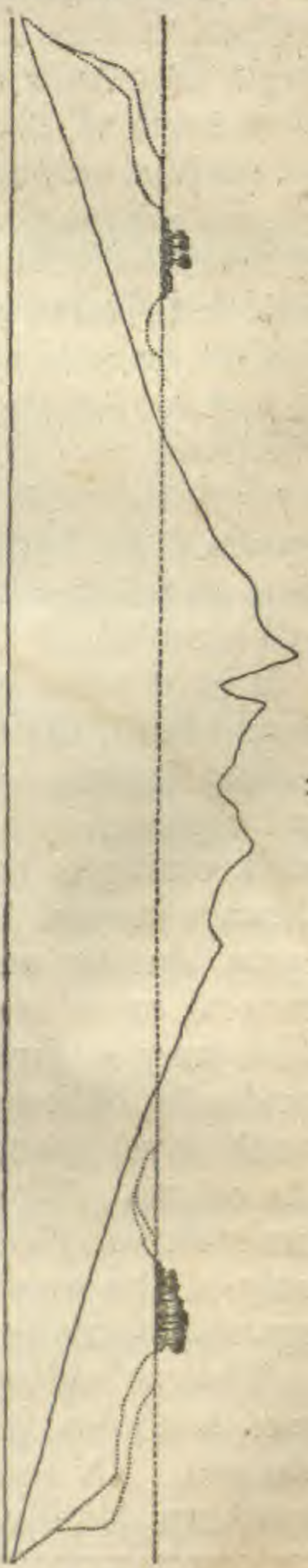
B. *Lagoons of Atolls.*—We pass from these remarks on the channels and seas within barrier reefs, to the consideration of the seas or lagoons of coral atolls. The inference has probably been already made by the reader, that the same subsidence which has produced the distant barrier, if continued a step further, would produce the lagoon island. Nanuku is actually a lagoon island, with a single mountain peak still visible; and Nuku-Levu, north of it, is a lagoon island, with the last peak submerged. This mode of origin may evidently be true of all atolls; for with the exception of the points of high land in the inner waters, there is no one essential character, distinguishing many of the Eastern Feejee islands from the Carolines to the North. The Gambier group, near the Paumotus, appears to have afforded the philosophical mind of Mr. Darwin the first hint with regard to the origin of the atoll; the contrast, and, at the same time, the resemblance, was striking; the conclusion was natural and most happy.* As some interest is connected with the history of new principles, and the illustration afforded is highly satisfactory, we have given a sketch of the Gambier group, (fig. 4, p. 189.) The very features of the coast,—the deep indentations,—are sufficient evidence of subsidence to one who has studied the character of the Pacific islands:† for these indentations correspond to valleys or gorges formed by denudation, during a long period, while the island stood above the sea.

The manner in which a farther subsidence results in producing the atoll, may be illustrated by fig. 5, p. 189. Viewing V, as the water line, the land is entirely submerged; the barrier, b'''', b'''', is an angular reef, enclosing a broad area of waters, or a *lagoon*,

* Captain Beechey, in his voyage in the Pacific, implies this resemblance, when he says of the Gambier group, which he surveyed, "It consists of five large islands and several small ones, *all situated in a lagoon formed by a reef of coral*,"—p. 120, Amer. ed. Balbi, the geographer, as Mr. Darwin remarks, describes those barrier reefs which encircle islands of moderate size, by calling them atolls, with high lands rising from their central expanse.—Darwin, op. cit., p. 41.

† This subject is discussed in the chapter, on the author's Geological Report, on the valleys of the Pacific islands. See also this Journal, [2], ix, 48.

with a few island patches of reef over the peaks of the mountains.* At a still greater subsidence (to the line VI) the islets, excepting one, have disappeared, owing to their increasing less rapidly than the barrier. The lagoon is in exact correspondence, in all its characters, with those of atoll reefs. Should subsidence now cease, the reefs, no longer increasing in height, would go on to widen, and the accumulations produced by the sea would commence the formation of dry land, as exhibited in figure 6, (p. 189.) Verdure may soon after appear, and the coral island is finally completed. It is not impossible that the land should form in certain favorable spots, while the subsidence is in progress if it be not beyond a certain rate.



The annexed figure represents the effect of a cessation or diminution of subsidence on the barrier reef, about a high island. The barrier reef has become a finished island, and forms a green belt to the land. The figure shows a section of such a belt.

All the features of atolls harmonize completely with this view of their origin. In form they are as various and irregular as the outlines of barrier reefs. Compare Angau of the Feejees, with Tari-tari of the Tarawan Group; Nairai or Moala with Tarawa; Nanuku with Maiana or Apamama. The resemblance is close; and in the same manner we might find all the forms of lagoon reefs represented among barrier reefs. We observe all those configurations which would be derived from land of various shapes of outline, whether the narrow mountain ridge, (as at Taputeouea, one of the Tarawan Islands,) or wide areas of irregular slopes and mountain ranges. Among the groups of high islands, we observe that abrupt shores may occasion the absence of a reef on one side, as on Moala; and a like interruption is found among coral islands. Many of the passages through the reefs may be thus accounted for.

The fact that the submerged reef is often much prolonged from the capes or points of a coral island, accords well with

* As the lagoon islets cover the summits of the subsided mountains, they afford the most favorable spots for reaching the rocks below by boring. In fig. 6, p. 189, the depth required for this purpose on an islet in the lagoon would be hardly a fourth what would be necessary on the enclosing reef.

these views. These points or capes correspond to points in the original land, and often to the line of the prominent ridge; and it is well known that such ridge-lines often extend a long distance with slight inclination compared with the slopes or declivities bounding the ridge on either side.

Coral islands or reefs often lie in chains like the peaks of a single mountain range:—for example, the sickle-shape line of islets north of Nanuku. Taritari and Makin, (Tarawan group, see map in vol. xii,) lie together as if belonging to parts of one island. Menchicoff atoll, in the Caroline Archipelago, consists of three long loops or lagoon islands, united by their extremities, and further subsidence might reduce it to three islands.*

The sizes of atolls offer no objection to these views, as they do not exceed those of many barrier reefs. Some of the larger Maldives, according to the crater theory, would require a crater seventy miles in diameter, with a rim made up of subordinate craters. No hypothesis of such extravagance is necessary. The facts all fall in with known principles, and are illustrated by known and established truths, without hypotheses of any kind.

It is of some interest to follow still further the subsidence of a coral island, the earlier steps in which are illustrated in the preceding figures. One obvious result of its continuation is a gradual contraction of the lagoon and diminution of the size of the atoll, owing to the fact already noted, that the detritus is mostly thrown inward by the sea. The lagoon will consequently become smaller and shallower, and the outline of the island in general more nearly circular. Finally, the reefs of the different sides may so far approximate by this process, that the lagoon is gradually obliterated, and the large atoll is thus reduced to a small level islet, with only traces of a former depression about the centre. Thus subsidence is connected with detritus accumulations in filling up the lagoon; and as filled lagoons are found only in the smallest islands, such as Swains and Jarvis, the two agencies have beyond doubt been generally united.

This subsidence, if more rapid than the increase of the coral reef, becomes fatal to the atoll, by gradually sinking it beneath the sea. Of this character evidently is the Chagos Bank.† The southern Maldives have deeper lagoons than the northern, fifty

* See Darwin on the probable disseverment of the Maldives, op. cit., p. 37, in which he points out indications of a breaking up of a large atoll into several smaller. A land with many summits or ranges of heights may at first have its single enclosing reef; but as it subsides, this reef contracting upon itself may encircle separately the several ranges of which the island consisted, and thus several atoll reefs may result in place of the large one; and further, each peak may finally become the basis of a separate lagoon island, under a certain rate of subsidence or variations in it, provided the outer reef is so broken as to admit the influence of waves and winds. The Maldives are a good example of this result. Some of the large atolls are properly atoll archipelagos.

† For a detailed account of this and other submerged reefs, see Darwin, p. 106.

or sixty fathoms being found in them. This fact indicates that subsidence was probably most extensive to the south, and perhaps also most rapid. The sinking of the Chagos Bank still further south, in nearly the same line, may therefore have some connection with the subsidence of the Maldives.

In view of the facts which have been presented, it appears that each coral atoll once formed a fringing reef around a high island. The fringing reef, as the island subsided, became a barrier reef, which continued its growth while the land was slowly disappearing. The area of waters within finally contained the last sinking peak: another period, and this had gone—the island had sunk, leaving only the barrier at the surface and an islet or two of coral in the enclosed lagoon. Thus the coral wreath thrown around the lofty island to beautify and protect, becomes afterwards its monument, and the only record of its past existence. The Paumotu Archipelago is a vast island cemetery, where each atoll marks the site of a buried island. The whole Pacific is scattered over with these simple memorials, and they are the brightest spots in that desert of waters.

Art. XV.—*Observations on the Freezing of Vegetables, and on the Causes which enable some Plants to endure the action of extreme Cold;* by John Le Conte, M.D., Professor of Natural Philosophy and Chemistry in the University of Georgia.

(Concluded from page 92.)

The foregoing observations afforded no very satisfactory information in relation to the condition of the fluids of the proper *woody structure:*—they furnished positive evidence only with respect to the state of the juices contained in the succulent layers of the inner bark. During their progress, I endeavored to examine some transparent sections of the plants by means of a compound microscope; but it was found to be so difficult and unpleasant to carry on such observations in the open air, that I determined to make use of artificial cold in the prosecution of the investigation. With this view the following experiments were instituted; the frigorific agent being a mixture of snow and common salt.

For the pupose of testing the effects of cold, I selected the internodal portions of a vigorous freshly-cut elder stalk (Sambucus canadensis), of about *one inch* in diameter: the diameter of the pith was nearly *one-half* that of the stalk. The pith of this plant is surrounded by a zone about one-twentieth of an inch in thickness, which is more succulent than the central portions of the pith proper, and from which fluid could be readily pressed by lateral compression *in situ* with the back of a knife. A smaller, but sensible, quantity of fluid could, likewise, be expressed from any portion of the pith, so as to appear on the cut surface, and which would disappear as soon as the compressing force was withdrawn. It was also found, that fluid appeared at the transverse cut surface of the liber, when pressed against the subjacent wood at the extremities. It was hoped, that the application of the foregoing tests, would enable us to ascertain with considerable certainty, whether the juices of these portions of the plant could be readily frozen, independently of any light which microscopic examination might throw upon the question.

Experiment No. 1.—February 2nd, 1851, 1 o'clock, P. M.; the temperature of the room being 42° Fahr., and that of the freezing mixture varying, during the experiment, from 2° to 5° Fahr. With the view of excluding the direct contact of the frigorific mixture, the internode of elder was inserted into a water tight tinned sheet-iron case or cylinder, of nearly the same diameter as the stalk,—the whole was plunged vertically, and in the natural growing position, into the freezing mixture; about seven-eights of the internode being below the surface. At the expiration of *two hours*, the stalk was removed from the case for examination. The extremity which was above the cold mixture, was found to be surrounded by a thin transparent coating of ice. The fluid seemed to have been forced up along the inner bark and the succulent zone surrounding the pith, by the contraction which took place in the part of the stem below the mixture, before congelation supervened. The *lower* extremity was found to be quite free from external ice, and appeared comparatively dry. The fluids of the bark, as well as those of the succulent zone around the pith, were obviously *congealed*. The frozen condition was rendered evident, by slicing the bark longitudinally with a sharp knife,—the ice could be scraped off with the edge of the instrument. In like manner, small masses of solidified juice could be detached from the succulent zone as well as the pith.

Under the microscope,—when a transverse section was made with a knife which was artificially cooled, and placed on a plate of glass which was cooled in the same manner,—the process of thawing was quite conspicuous and beautiful, especially in the succulent zone. In the woody structure, the process of liquefaction was manifested by the rapid appearance of *bright apertures*, which were mere translucent points when first placed under the glass. Slices of wood which had not been subjected to the influence of cold, presented *no changes* under the magnifier. As it is necessary to make the slices very thin, in order to secure the requisite degree of transparency, the thawing takes place with great rapidity. The observations must, therefore, be made quickly:—the knife with which the slices are made, as well as the glass plate on which they are placed for examination, should be artificially cooled.

Experiment No. 2.—In the previous experiment, the lower extremity of the internode of elder was exposed to the action of the cold, and it might be supposed, that the frigorific influence was propagated along the stalk *longitudinally*, the direction in which the experiments of MM. Aug. De La Rive and Alph. De Candolle show, the conducting power of wood to be the greatest. For the purpose of obviating this difficulty, a hollow tin cylinder, six inches in length, open at both extremities, was passed transversely through the centre of the opposite sides of a small wooden box. Another recently cut internode of elder was thrust through the cylinder, having both extremities projecting several inches beyond the ends of the metallic case, so that, only the *middle portions* would be subjected to the frigorific influence. On the 6th of Feb., 1851, at 1 o'clock P. M., the temperature of the room being 37° Fahr., the freezing mixture was introduced into the box. At the end of *two hours,*—the temperature of the mixture varying from 2° to 6° Fahr.,—the stalk was withdrawn for examination. The bark in the middle of the part which had been exposed to the cold, was *found frozen* as in the previous experiment; neither the bark, succulent zone, pith or wood at the *extremities*, exhibited any indications of congelation of the fluids contained in them. The middle of the stalk was then cut through by means of a small saw which had been artificially cooled. On examining the transverse section, the liber and succulent zone around the pith were evidently frozen; portions of solidified sap could be removed with the point of a knife. Under the microscope, the thawing of thin transverse slices of the woody structure, was manifested by a series of changes identical with those observed in the first experiment. Indeed, the physical properties of the wood were sufficiently modified to indicate the frozen condition by the use of a cutting instrument:—it was harder than natural, and the section presented a *polished glassy appearance.* At the same time, a portion of the branch of a *Pinus tæda* was subjected to the same degree of cold. The microscope revealed the fact, that its juices were, likewise, frozen,—a similar change, indicative of thawing, being clearly observable.

Experiment No. 3.—The foregoing experiments were tried on portions of plants which had been recently cut from the parent stem or branch, and it might be imagined that the case would be different with a *growing* plant. For the purpose of testing the validity of this idea, two vigorous shoots of the Ailanthus,—which had been planted in a large box of earth,—were, on the 19th of Feb., 1851, submitted to experiment. The temperature of the room was 56° Fahr., that of the freezing mixture varied from 0° to 5° Fahr. Tin tubes were placed around the base of the stems, so as to protect them from the immediate contact of the mixture. The frigorific material was kept around each tube by means of two small wooden boxes, which were perforated at the centre of the bottom, so as to permit the tubes and contained stems to pass vertically through. At the expiration of *four hours*, the cold mixture was removed from one of the shoots, and it was cut through the middle of the part which had been exposed to the cold. The juices of the bark and wood were evidently frozen. This was rendered obvious by placing transparent slices of them under the microscope, as in the previous experiments. It was, likewise, proved by the fact, that, at first, when cut with a cold knife, none of the juices were forced out by the passage of the cutting instrument; but after a short time, when thawing had taken place, any attempt to slice the wood transversely would render the presence of the fluids manifest on the cut surface. The *other shoot* was allowed to remain undisturbed for *six hours* after which, the frigorific mixture was removed, and the box of earth in which it was planted placed in the open air, for the purpose of ascertaining what effect the cold might have on its *vitality*. About the middle of March, the buds began to swell, and in due season, the leaves were developed. The shoots of Ailanthus on which these experiments were tried, were suckers of two years growth.

From the preceding experiments, two conclusions seem to be legitimately deducible. *First*, that the sap of certain plants *can be* readily frozen by the application of a comparatively *moderate* degree of cold. For, although, the temperature of the frigorific mixture varied from 0° to 6° Fahr., yet, as there was a metallic tube surrounding the stem, the temperature of the latter must have been considerably higher. Direct observation proved this to be the case: a thermometer introduced into the metallic case never indicated a temperature lower than 15° Fahr. It must also be borne in mind, that as the *duration* of the frigorific action was never more than from *two to four hours*, the *central* portions of the stems submitted to experiment, must have possessed a temperature notably *higher* than the exterior parts: and yet, the structures around the *pith* were found congealed. Moreover, a degree of cold equal to zero of Fahrenheit is quite *moderate* in comparison with the natural cold endured by the very plants on which the experiments were performed. And *secondly*, that congelation of the juices of vegetables *does not*—as many physiologists imagine,—necessarily and inevitably result in the death of the whole plant, or of the *part* in which it takes place; but, on the contrary, that frequently, *no injurious consequences follow.*

With such a state of facts before us, we should naturally expect, that in high latitudes, the sap of all perennial plants must be frozen during several of the winter months. *Such I believe to be the fact.* Robert Boyle informs us, on the authority of Capt.

James, that at Charleston Island (now called Charles Island) in Hudson's Bay, the trees had to be *thawed by fire before they could be cut down.** I have been credibly informed, that the "lumberers" of Maine and New Hampshire are familiar with the fact, that during periods of extreme cold, the sap of many of the forest trees becomes so frozen, that the physical qualities of the wood are altered to such an extent, *that it is difficult to cut it with an axe.* M. Duhamel observes, that the maples in Canada, where the frost is long and severe, begin to bleed, when wounded, with the first thaw, and stop again when it freezes; and that this, in frosty days, occurs only on the south side of the tree.† In all these cases, it is sufficiently obvious, that the freezing of the sap could not have been fatal to the life of the trees; for, in that event, a single severe winter would destroy every plant.

But, perhaps, it may be granted, that the foregoing experiments and observations, are sufficient to prove, that the juices contained in the *aërial or ascending stems* of many plants may be frozen without destroying the power of vegetation; and yet, it may be asked, does not the complete congelation of the fluids included in *all parts of the vegetable*, comprehending the root or descending axis and its appendages, *necessarily* result in the destruction of its vitality? Even the admission that *large portions of the aërial stem* may be frozen with impunity, impresses the character of error upon the commonly-received opinion among many of the most eminent phytologists; but, I think, facts are not wanting to show, that the juices contained in *every part of some plants*, may be congealed without injury to the powers of vegetation. Although Leopold von Buch and many other philosophers, even as late as 1825, were disposed to reject the statement of the elder Gmelin, that the ground is perpetually frozen in the northern parts of Siberia; yet, the fact has been abundantly corroborated in our days by the observations of MM. Adolph Erman, von Humboldt, Hansteen, Schergin and others. At the town of Yakutsk, in latitude 62°, M. Schergin attempted to sink a well and was about to abandon the project in despair of obtaining water, when Admiral Mangel persuaded him to continue his operations until he had perforated the whole stratum of ice. This he did, and kept a complete journal of the work. The well was dug to the depth of nearly 400 feet, with the following most remarkable results as to the temperature of the ground:‡

50 English feet,	. .	18°·5 Fahr.
77 " "	. .	19 ·6 "

* Vide Boyle's works, vol. ii, p. 274. London, 1744.

† Physique des Arbres, vol. ii, p. 258.

‡ Vide Erman, Comptes Rendus de l'Acad. des Sciences, tome vi, p. 501, 1838; also von Baer, in Edinb. New Phil. Journ., vol. xxiv, p. 435, 1838.

119 English feet, . .	22°· Fahr.
217 " " . .	27 ·5 "
305 " " . .	28 ·6 "
382 " " . .	31 "

From which it appears, that the soil at this place is frozen to the depth of about 400 feet. Observations kept at Yakutsk for a series of years, show that the mean temperature of the year is nearly 14°·5 Fahr.* In winter, a degree of cold exceeding –58° Fahr. takes place every year. The mean temperature of two winter months is below –40° Fahr.; so that mercury is solid for *one-sixth* of the year, and has been known to remain frozen during *three consecutive months!*† A comparatively warm summer is joined to this cold winter; the mean temperature of June, July and August being 56°·75, 65°·75 and 61°·25 Fahr. respectively, and the maximum heat of the summer day is sometimes as great as 77° Fahr. During the 128 days of the year in which there is no frost at Yakutsk, the strata of eternal ice are never thawed to a greater depth than *three feet*, and yet, "vegetable life continues not merely uninjured, but is favored in the highest degree by the equable and very rapid increase of heat."‡ This is not restricted to *annual* plants; for M. Erman informs us that noble larch forests (Pinus larix) flourish on the east side of this town, where their roots rest upon inferior strata of perpetual frozen earth, and where, even the superficial stratum in which they are imbedded, is frozen for nearly *eight months of the year!* As it is physically impossible that the roots of these trees can penetrate deep enough even to *approach* the stratum of *invariable temperature* in this high latitude, the *whole plant*, including the descending axis and its appendages, must, during the winter, be exposed to a degree of cold considerably below the zero of Fahrenheit.

Is it possible to imagine, that the sap of these trees remains unfrozen in a climate where mercury is solid during *one-sixth* of the year, and where the stratum of perpetual ground-ice extends to the depth of 400 feet? Here we have an *extreme case*, in which it is sufficiently obvious, that no known combination of vital and physical causes could prevent the fluids contained in these plants from undergoing congelation every winter: the conclusion seems, therefore, to be unavoidable, that *they are actually*

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* Vide M. Mahlmann's table of mean temperatures, in Kaemtz's Complete Course of Meteorology. English Translation by C. V. Walker. London, 1845, p. 177. Erman puts down the mean temperature of this place at 18°·5 Fahr.

† Vide Adolph Erman's Travels in Siberia, translated from the German by W. D. Cooley. Philadelphia, 1850, vol. ii, p. 278; also Comptes Rendus, (Paris) tome vi, p. 502.

‡ Erman. Op. cit. supra., vol. ii, p. 279.

frozen at this period of the year, and, consequently, that such an accident *is not always injurious* to vegetation.*

Neither is the example of Yakutsk an isolated one: for a great part of the vast territory of Asiatic Siberia, and a smaller portion of Europe and North America, lying north of the isothermal line of 32° Fahr., support extensive forests of birch, (Betula alba,) Norway spruce, (Pinus abies,) larch, (P. larix,) Cembra pine, (P. cembra,) Scotch fir, (P. sylvestris,) white spruce, (P. alba,) American silver fir, (P. balsamea,) and black spruce fir, (P. nigra,) where the ground-ice is perpetual.† These facts appear to warrant the conclusion of M. Adolphus Erman, namely: that it is now fully established, "that many arborescent plants require as the condition of their thriving, only the summer heat and the humidity of the air that suits them; and that they are, therefore, not only quite insensible to the rigor of winter, but, in spreading over the plains and mountains of the earth, *are wholly independent of the temperature of the ground or mean temperature.*"‡ The development of leaves and vegetation depends less on the temperature of the soil, than on that of the air in the spring and summer: it only requires that the ground should be so far thawed, that the tree may be able to draw from it sufficient moisture for its growth. This is especially true of several species of the coniferæ; for many of them are enabled to brave the most rigorous winters, and pass through all the phases of flowering and fructification, provided the summer be hot enough, and of sufficient duration.

But it may be objected, that when the sap contained in the trunks of trees becomes frozen, it *cleaves* them with a great noise, —a phenomenon not uncommon in high latitudes,—and that, therefore, the fact that the majority of them *are not* thus cleft, *proves that their juices have not been congealed.* It is proper to remark, *en passant,* that even in the cases where the trunks of trees *are split* by cold, *it does not always result in the death of the plant;* although the wood is generally rendered unfit for the purposes of timber. This effect has been, almost universally, ascribed to the expansion which the sap undergoes during the process of congelation;—a force abundantly adequate to produce such a result, *provided all parts of the tree were perfectly rigid*

* The lowest temperature that has yet been observed on the earth, is probably that noted by Neveroff, at this place (Yakutsk) on the 21st of January, 1838. "The instruments used in this operation were compared with his own by Middendorff, whose operations are always conducted with extreme exactitude. Neveroff found the temperature on the day above-named, to be −76° Fahr." (Humboldt's Cosmos, (Bohn's Scientific Library,) translated from the German by E. C. Otté, vol. iii, p. 43. London, 1851.) The maximum natural cold previously recorded, is −70° Fahr.; being that observed by Capt. Back at Fort Reliance in January, 1834.

† Vide Johnston's Physical Atlas.

‡ Vide Travels in Siberia. Ed. *cit. supra,* vol. ii, p. 360.

and unyielding. As it is manifest, that this condition *does not* obtain in any tree, I am disposed to think that this opinion is erroneous, and that the effect here referred to, *is not the result of the freezing of the fluids*, and consequently, is not a necessary accompaniment of that phenomenon. The following considerations have led me to refer the cleaving of trees by cold, *to the unequal contraction which takes place in the trunk* (usually after the complete congelation of its juices) *in consequence of a sudden depression of temperature.*

1. Observations show, that the *oldest and largest* trees are usually those which are cleft; while the younger trees exhibit no such effects. In the account given by J. Evelin of the effects of the great frost which occurred in England during the winter 1683–4, we are informed, that "the rifting so much complained of, has happened chiefly among the overgrown trees, especially oaks," whereas, elms of only twenty-five or thirty years standing, were untouched.* Now, if *freezing of sap* is the cause of the phenomenon, young and small trees would certainly be more liable to be cleft; both on account of the greater accessibility of their interior parts to the exterior atmospheric changes, and the presence of a greater amount of fluid in their tissues. On the contrary, if the effect is produced by the *contraction* of the exterior layers of wood, we should naturally expect the rifting to take place in old trees, where the heart wood is indurated and of course unyielding.

2. The same effect is produced by extreme cold on *dry and seasoned timber.*† At Prince of Wales' Fort on Churchill river near Hudson's Bay, Capt. Middleton noticed that *trees, joists and rafters* were burst with great noise from the effects of cold.‡ Near Moscow the timber-work of houses is frequently observed to crack during severe winters.§ Other instances might be cited; but the effects of cold in temporarily widening the small cracks produced by ordinary desiccation in posts and pillars, must be so familiar to every one, that farther notice is unnecessary. Is it reasonable to suppose, that in these cases, the splitting is caused by the congelation of the comparatively small amount of hygrometric moisture which is known to be present in the best seasoned wood? On the other hand, is it not obviously a phenomenon of unequal contraction, precisely analogous to the smaller fissures produced by rapid desiccation?

3. All travellers in high northern latitudes, testify that the very rocks are sometimes rent asunder by the intensity of the cold, and that the ground is frequently cleft by the same cause,

* Vide Phil. Trans., vol. xiv, p. 559. Abridged, vol. ii, p. 153.
† Vide Phil. Trans., vol. xiv, p. 559.
‡ Phil. Trans., vol. xlii, p. 157.
§ Boyle's works, vol. ii, pp. 274 et 276. London, 1744.

producing openings many yards long and ten or twelve inches wide. Such phenomena cannot be ascribed to the expansive power of freezing water, because they occur during mid-winter, and in latitudes where the rigor of the climate is such, that the earth is frozen 300 or 400 feet deep, (certainly far below the depth of these superficial fissures,) long before these effects are observed. They are unquestionably the result of superficial contraction produced by the sudden application of intense cold, and are precisely analogous to the fissures which originate in clay and mud during the process of drying.

4. Ice itself is frequently known to crack from the same cause. Of this character were the fissures in the ice—some of them *four inches* wide—which M. Erman observed near Bol-Atluimsk on the Obi and at Posolskoi. He very correctly ascribes them to the cooling and contraction of the upper stratum of ice *subsequent to its perfect congelation.** Such facts are matters of the most common observation in all climates where the cold is of sufficient intensity to maintain water in a solid condition for any considerable portion of the winter. The cracking always takes place during periods of rapid augmentation of cold. To those who may be incredulous as to the *adequacy* of superficial *contraction* to produce the observed effects, it may be proper to state, that according to the experiments of MM. Brunner and Schumacher, the contraction of ice consequent upon a diminution of temperature, is greater than that of any other solid body hitherto examined. The former found the amount of linear contraction to be equivalent to ·00002083 for a degree of Fahrenheit; the latter obtained a still higher result, viz: ·000029086.† It is well known that glass, in which the coefficient of dilatation is very small, will readily crack by the sudden application of cold.‡

The facts and considerations above detailed, seem to point to the unequal contraction produced by the sudden application of cold, as the true cause of the bursting of trees in rigorous climates. Whatever may be thought of the universality of this cause, direct experiments and observations prove, that congelation of the sap *per se*, *does not* invariably produce the effect. It appears to us infinitely more probable, that the rifting supervenes subsequent to complete congelation of the juices: first, because the *increased non-conducting power* of the woody structures under these circum-

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* Erman's Travels in Siberia. Ed. *cit. ante.* vol. i, p. 331, et vol. ii, p. 218.

† Vide Ann. de Chim. et de Phys., 3d series, vol. xiv, p. 369—1845, as cited in Silliman's Journal, 2d series vol. i, p. 117—1846; also vol. iii, p. 450 of the same Journal.

‡ In two recent series of experiments, independent of each other, MM. Pohrt and Moritz have found the linear expansion of ice for an interval of *one degree* of Fahrenheit's scale, to be 0·0000285 and 0·000028778: fractions nearly accordant with the results of Schumacher's experiments. (Vide Liebig and Kopp's Report on the Progress of Chemistry, etc. English Translation, vol. i, p. 44. London, 1849.)

stances would, of necessity, tend to establish a greater *inequality* of contraction, when the frigorific influence began to operate, and, therefore, a greater liability to rupture; and secondly, because the greater *rigidity* of the interior parts of a tree whose juices are frozen, would tend to bring about the same result upon a sudden reduction of temperature. The reason why some species of trees are more liable to be rifted by cold than others, is, probably, attributable to a difference in the compressibility of their structures when in a frozen condition.

But it may be asked, if the *freezing of the sap* does not always kill plants, in what manner does cold produce death in vegetables? As this is a point which has been investigated by Göppert, Morren, Lindley and others, I do not propose to notice it farther, at this time, than to indicate the learning of their deductions on the subject under consideration. The observations of MM. Göppert and Morren seem to prove, that the common opinion, that cold acts mechanically upon the tissues of plants, by expanding the fluid they contained and bursting the cells or vessels in which it is enclosed,—is totally untenable; such supposed laceration of the vegetable tissues seldom, if ever, taking place even when the most succulent plants are frozen and killed by cold. During the process of congelation, each cell of the tissue becomes individually larger, by the augmentation of volume which attends the solidification of the contained fluid; but there is *no bursting*, because the membrane is *extensible*, and when thawed, the cell recovers itself by its elasticity. The more recent observations of Professor John Lindley, are, on the whole, confirmatory of these conclusions. For although, in some instances, he found the tissue of the succulent parts of plants lacerated, as if by the dilation of the fluid it had contained; yet, this result was by no means an invariable concomitant of freezing, and it is not essentially connected with the destruction of vegetable life. Upon a careful review of all the facts, Prof. Lindley concludes, "that the fatal effects of frost upon plants is a more complicated action than has been supposed; of which the following are the more important phenomena:—

"1. A distension of the cellular succulent parts, often attended by laceration, and always by a destruction of their irritability.

"2. An expulsion of air from the aeriferous passages and cells.

"3. An introduction of air, either expelled from the air passages or disengaged from the water during the act of freezing, into parts intended exclusively to contain fluid.

"4. A chemical decomposition of the tissue and its contents, especially the chlorophyll.

"5. A destruction of the vitality of the latex and a stoppage of the action of its vessels.

"6. An obstruction of the interior of the tubes of pleurenchyma (woody fibre) by the distension of their sides."*

It will be observed, that the phenomena are partly mechanical, partly chemical, and partly vital. So far as the mechanical effects are concerned, it is very plain, that whatever increases the amount of moisture in the plant, augments the liability to laceration of tissues, when freezing supervenes. In relation to the chemical and vital phenomena, it is sufficiently obvious, that the effects of cold must vary with the condition of the fluids in the plants. The well-known evil influence of cold in the spring, or after a warm spell in winter, is, probably, referable to the augmented *susceptibility* which seems to attend the *growing state.* It is difficult to say whether this increased susceptibility to the action of cold, is due to an alteration in vital sensitiveness, or to a proneness in the fluids to enter into chemical decomposition.† Possibly, both causes may be in operation: but additional observations and experiments are wanting to clear up many points relating to the *exact manner in which the death of plants is caused by cold.* Nevertheless, whatever may be our degree of ignorance in relation to these points, it is hoped that we have succeeded in establishing the fact, *that the destruction of life is not an invariable concomitant of the congelation of the juices of plants;* and consequently, that they *have not* the relation of effect and cause. Indeed, the proof of this may be considered two-fold; *both negative and positive.* For it is well known that many tropical exotics are destroyed by a degree of cold considerably *above* the freezing point of water, when, of course, their sap cannot be in a state of congelation: while, on the other hand, as I have endeavored to show in this memoir, the juices of other plants are obviously and repeatedly *frozen* without the slightest injury to the powers of vegetation.

The analogy between animals and vegetables seems to be, in this respect, almost as perfect as it is remarkable. A degree of cold which alsolutely freezes the fluid contained in their structures *is not* equally fatal to all plants. As among animals, each species of plant is adapted to endure a certain range of temperature, which determines, with more or less precision, the limits of its geographical distribution. The fact that vegetables are less susceptible to the injurious influence of cold when in a *dor-*

* Vide Prof. A. Gray's Abstract of Prof. Lindley's Memoir, in Silliman's Journal, 1st series, vol xxxix, p. 18, et seq.—1840.

† It is very probable that the injurious effects of cold upon *growing* plants, may be, in part, due to the sudden stoppage of the changes which attend the process of active cell-development. It is reasonable to suppose, that any disturbance of this process at such a period, would lead to rapid and fatal chemical reactions. The well-known fact that, in frozen potatoes, all the starch is converted into dextrin and sugar, shows that important chemical changes may be brought about by the influence of cold.

mant state, seems to be a wise and inestimably excellent provision appointed by nature for the preservation of the vitality of the system against the extreme cold of winter. Observations and experiments are yet wanting to determine, whether those members of the animal kingdom, which have little or no power of resisting external changes of temperature, are endowed with a like *increased* immunity from the injurious effects of cold, during the period of hybernation. On a future occasion, I hope to make this point a subject of special investigation.

University of Georgia, July 4th, 1851.

ART. XVI.—*On the Compound Ammonias, and the bodies of the Cacodyle Series;* by T. S. HUNT, Chemist to the Geological Commission of Canada.

THE beautiful researches of Hofmann and Wurtz have shown the existence of a large class of organic alkaloids closely related to ammonia, which have already been noticed at different times in this Journal.* As regards their composition, we will only recall that in the alkaloids of Wurtz, the elements of an equivalent of ammonia are united with those of a carbohydrogen, CH_2, C_2H_4 C_5H_{10} or what is the same thing, that CH_3, C_2H_5 and C_5H_{12}, the so-called radicals, methyl, ethyl, and amyl, may be regarded as replacing an atom of hydrogen in ammonia. Hence, as we have before remarked in speaking of them, "they sustain to their corresponding alcohols the same relation that ammonia does to water.† Water, as we have on more than one occasion shown, is not only the analogue, but the strict homologue of the alcohols, so that the molecule H_2 is the equivalent (homologue) of C_2H_6 and its homologues, and H of ethyl, methyl and amyl.‡ The class of bodies under consideration presents some interesting illustrations of this relationship.

Mr. Hofmann has been able by the action of ammonia upon hydrobromic and hydriodic ethers, to form directly the corresponding salts of the new alkaloids, and these alkaloids, with other equivalents of the ethers, have yielded him compounds in which two and three equivalents of hydrogen are replaced by the same or by different carbo-hydrogens; so that representing C_2H_5 by Et, the final result of the action of ammonia is $N\,Et_3$, which is still an alkaloid. Other carbo-hydrogens not homologous with ethyl may be introduced, and Hofmann has obtained alkaloids containing one and two equivalents of phenyl C_6H_5, with one or more of ethyl.

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* See [2], vol. ix, p. 66; xii, pp. 115, 428.
† This Journal, vol. ix, p. 65.
‡ Ibid, and vol. v, p. 265.

Although ammonia and its derived alkaloids form with acids, salts analogous to those of the inorganic bases, they must be distinguished from oxyds like Zn_2O, inasmuch as they unite directly with HCl and NHO_3, while the oxyds yield salts only by the elimination of water; in chlorid of ammonium it is the hypothetical NH_4, which represents Zn in the chlorid of zinc. The analogy between Zn_2O and H_2O leads us to suppose the possibility of such a compound as the oxyd of ammonium which would be formed by a direct union of ammonia with the elements of water. But such compounds, if they exist, are very unstable; and as the alkaloids are either readily disengaged from their aqueous solutions by heat, or else are insoluble in water, it is very difficult to prove the existence of these oxyds. If, however, an alkaloid could be made to unite with a homologue of water, the elements corresponding to H_2O might form a more stable combination, and the reality of the action be established. Such a result has actually been attained by Mr. Hofmann, who has indirectly formed a combination of triethammine with alcohol. An ammonia uniting with water which has two atoms of replaceable hydrogen, might form either $NH_5O = NH_4, HO$ or $N_2H_8O = (NH_4)_2O$. Did triethammine unite directly with hydric ether, we might obtain the alcohol compound corresponding to the latter oxyd, but alcohol is Et HO containing but one atom of C_2H_5, and consequently we have $N Et_4, HO$. It is obtained by the action of triethammine upon iodid of ethyl, which is the homologue of hydriodic acid; and as the acid produces with ammonia the iodid of ammonium, the ether yields the iodid of the new quasi-metal *tetrethylammonium*, which, when decomposed by oxyd of silver, yields the hydrated oxyd of the new base $(N Et_4 H)O$, corresponding to (KH)O, hydrate of potash, which it closely resembles in its acridness, causticity and powerfully alkaline characters, particularly as shown in its reactions with metallic salts, and in its power of saponifying oils. Although termed an organic alkaloid, it will be seen that this and its analogous compounds cannot be assimilated to the organic bases containing oxygen like quinine, with which they have been compared, as the latter combine directly with acids and carry their oxygen into their saline combinations, while Hofmann's bases eliminate an equivalent of water which contains their atom of oxygen.

The action of an alloy of potassium and antimony upon the iodid of ethyl, has furnished to MM. Löwig and Schweizer a volatile liquid, spontaneously inflammable and having the formula $C_6H_{15}Sb$, which corresponds to triethammine, in which N is replaced by Sb.* It does not appear whether it forms direct

* Jour. für Prakt. Chem., t. xlix, p. 385, t. l, p. 321, and this Journal, vol. x, p. 263.

compounds with acids. When slowly oxydized it takes up an equivalent of oxygen and yields a viscid liquid which combines with acids, and forms salts with the elimination of an equivalent of water. M. Gerhardt has shown that this compound, which the authors designate as *oxyd of stibethyl*, is to be regarded as the hydrate of a new base, $C_6H_{13}Sb$, for which he proposes the name of *stibethine*;* it is formed from stibethyl by the loss of H_2, as harmine is derived from harmaline. The constitution of the hydrate is analogous to Hofmann's new ammonium bases; $SbC_6H_{13}, H_2O = (SbC_6H_{14}, H)O$, and SbC_6H_{14} is equivalent to NH_4, ammonium. Nitric acid oxydizes H_2 in stibethyl and forms an acid nitrate of stibethine. Sulphur, chlorine and bromine combine directly with stibethyl, yielding compounds which have all the characters of salts of stibethine and may be formed by double decomposition from the salts of the oxyd. Stibethyl even decomposes strong hydrochloric acid, evolving hydrogen to form a chlorid which is also produced by the action of a metallic chlorid upon the nitrate of stibethine; its composition is that of an acid salt, $SbC_6H_{13}, 2HCl = SbC_6H_{14}, Cl, HCl$. It reacts like a chlorid of potassium or sodium with metallic solutions, and forms with sulphuric acid a sulphate with disengagement of hydrochloric gas.

More recently M. Landolt has obtained the methyl compound analogous to stibethyl by a similar process.† It corresponds to trimethammine, being $SbC_3H_9 = SbMe_3$, and yields a series of compounds like those of stibethyl. When placed in contact with iodid of methyl, an energetic combination ensues, and a crystalline product is obtained which is $SbMe_4I$, the equivalent of Hofmann's iodid above described. Decomposed by oxyd of silver, the hydrated oxyd of the new base, which the author calls *stibmethylium*, is obtained; it closely resembles the oxyd of tetrethylammonium, and its salts are said to be isomorphous with those of potash. The author writes the formula of the iodid as above, and the oxyd $SbMe_4O$; this is evidently an error, the oxyd will be $(SbMe_4H)O$, like the corresponding nitrogen compound. He has observed that stibethyl yields similar compounds with iodid of ethyl, and with iodid of methyl, the analogous body $(SbEt_3Me)I$.

With these results before us, we are ready to inquire into the constitution of the bodies of the cacodyl series. It must be observed that the elimination of H_2 is characteristic of the alcohols, as is seen in the formation of aldehydes and acids, and they seem to preserve this same character in their combinations; thus the fourth ethyl atom which is combined with triethammine is decomposed at the temperature of boiling water into C_2H_4 and H_2O.

* Comptes Rendus des Travaux de Chimie, 1850, p. 400, and this Journal, vol. xii, p. 430.

† Ann. der Chem. und Pharm., lxxviii, p. 91.

Let arsenic replace nitrogen in Wurtz's *ethammine* $NC_2H_7 = NC_2H_5, HH$, and we have AsC_2H_7, from which if H_2 be abstracted, there remains $AsC_2H_5 = AsC_2H_3, HH$, a new base corresponding to stibethine; such a base is contained in the chlorid of cacodyl, and has been recognized by M. Gerhardt under the name of *arsine*,* of which the hydrochlorate and hydrobromate, are Bunsen's chlorid and bromid of cacodyl. The compound analogous to the oxyd of stibmethylium will be $(AsC_2H_5)_2, H_2O$ or $C_4H_{12}As_2O$, (equivalent to K_2O,) which is *alcarsine*. The relation between the oxyd and the chlorid is evident; it is difficult to believe that the bodies described by Bunsen as oxychlorid and oxybromid of cacodyl are any thing else than mixtures of alcarsine with hydrochlorate and hydrobromate of arsine, and the more so, as their composition after his analyses does not seem to be well defined. M. Bunsen did not analyze the compounds of alcarsine with oxygen acids; indeed only the sulphate seems stable; it is acid and deliquescent, and is probably a bisalt—the bisulphate of arsine.

The sulphuret of cacodyl is analogous to the hydro-sulphuret of ammonia, and arsine sustains to alcarsine the same relation as ammonia to oxyd of ammonium. It is worthy of notice that there are two conditions of alcarsine, the one a fuming and spontaneously inflammable liquid, and the other, formed during the slow oxydation of the first, a viscid, syrupy substance, comparatively indifferent to chemical agents, and but difficultly oxydized:—the viscid, inactive form corresponds to stibethine. Researches upon this variety of alcarsine and its salts would be very desirable. The compounds resulting from the action of chlorid of mercury and nitrate of silver with alcarsine, are probably compounds of arsine, analogous to the ammoniacal combinations of these salts. It is to be remarked that while the salts of stibethine are, from the very mode of their formation, acid, those of arsine, if we except perhaps the sulphate, are neutral.

Cacodyl is formed by the reduction of the hydrochlorate of arsine, *chlorid of arsenium*, by zinc; precisely as $2ZnCl + K_2$ give $2KCl + Zn_2$, we obtain chlorid of zinc with the elimination of arsenium, that is, of $AsC_2H_6 + AsC_2H_6 = C_4H_{12}As_2$. Cacodyl is thus precisely analogous to a metal, and with chlorine or sulphur yields compounds of the arsine series; the above formula however, represents two volumes of vapor, while the equivalent of the chlorid is represented by AsC_2H_6, Cl. I have however endeavored on a previous occasion to show that the atom of the metals in their free state is represented by M_2, and hence cacodyl corresponds perfectly to Zn_2, which in combining with chlorine, breaks up to form two equivalents of $ZnCl$; *alcargen*, cacodylic

* Prècis de Chimie Organique, vol. i, p. 389.

acid is not an oxyd of cacodyl, for its formula is $C_2H_5AsO_2$, and being anhydrous it is equivalent to a compound of ammonia with oxygen, and not of ammonium as M. Bunsen's theory demands.

MM. Löwig and Schweizer assert that by oxydation, stibethyl yields $C_4H_5Sb = Sb\,Et$, which combines with O_5, S_5. As we have no other evidence that the type of the ammonia is ever thus destroyed, it is more probable that the action removes H_2 from one atom of Et, as in the formation of stibethine, and oxydizes the two remaining atoms of ethyl, leaving H in their place; $Sb, C_2H_5 = Sb, C_2H_3, HH$, corresponding to arsine, and like it combining with O_2, S_2. (O_5 in their notation not being divisible by two, is inadmissible, unless the formula is to be doubled.) The properties of the new compound, *stibethylic acid* of the author, and $C_4H_5SbO_5$ in his notation, but more probably $C_2H_5SbO_2$, lead us to conclude that it is the antimonial species corresponding to alcargen, $C_2H_5AsO_2$. It is a white solid, soluble in water and alcohol but insoluble in ether, and is converted by H_2S, into an odorous compound, in which its oxygen is replaced by sulphur; the history of the body is not however complete.

I remarked four years since, that glycocoll is the nitrogen species corresponding to alcargen, and published in this Journal* some experiments upon the action of sulphuretted hydrogen upon nitrous ether, undertaken with the hope of obtaining the nitrogen compound corresponding to alcarsine. M. Laurent was, however, disposed to regard glycocoll as the amid of a bibasic acid $C_2H_4O_3$, the homologue of carbonic acid, and hence explained its monobasic acid character;† but to this view it is to be objected that the ordinary amids of bibasic acids are either neutral like oxamid, or acid without any basic characters like oxamic acid. Glycocoll is to be regarded as the isomere of glycollamic acid, precisely as the alkaloids, furfurine and benzoline are known to be isomeres—allotropic forms of the normal amids, and corresponds to ethammine less $H_2 + O_2$, or to the product which should be obtained by the oxydation of Sb Et. Its capacity to exchange H for K, is unlike that of acetic acid or alcohol, for the saline power of these belongs not to the carbohydrogen elements, but to the unreplaced H of the H_2O:—nor in this view is the saline hydrogen of glycocoll similar to that of oxamic acid; it is an atom of hydrogen in the ammonia itself, which is replaceable, as in asparagin, itself the binamid of a bibasic acid, and in paramid.‡

I conclude these observations by calling attention to the results obtained by Mr. Hofmann in decomposing the compound ammonias by a nitrite.§ I was the first to show that the elegant process by which Piria had succeeded in decomposing asparagin and

* Vol. iv, pp. 108—266, 350. † Ibid, vol. ix, p. 64.

‡ See my remarks on this subject in this Journal, vol. viii, p. 90.

§ Comptes Rendus des Travaux., Fev., 1851, p. 42, from Jour. de Pharmacie, t. xviii, p. 399.

some other amids, was applicable to the organic alkaloids, and that the action of nitric oxyd upon a dilute acid solution of nitrate of aniline yields nitrogen gas and phenol. Mr. Hofmann refers to my statement, but adds that in repeating my experiment the aniline was transformed into a brown mass containing a crystalline matter which was nitric phenol. He probably obtained the binitric species which is the first product of the action of nitric acid upon phenol, and which as described in my paper I actually prepared from the phenol thus obtained, by treating it with strong nitric acid, in the process for preparing the nitropicric acid. If, keeping in mind the great readiness with which phenol is attacked by nitric acid, he will take the trouble to repeat the experiment with a dilute solution of the salt, avoiding a large excess of nitric acid, he will not find it difficult to obtain the characteristic oily product which I have described, and which is not easily confounded with nitrophenesic acid.

By the use of nitrite of silver in accordance with my suggestion, for which he has found even nitrite of potash may be substituted, Mr. Hofmann was more successful. In distilling hydrochlorate of ethammine with a solution of nitrite of potash, nitrogen and nitrous ether were evolved, with a liquid containing apparently traces of alcohol and some drops of an oily matter. Similar results were obtained with butylamine, propylamine and amylamine. These nitrous ethers, as shown by M. Kopp and myself, are decomposed by sulphuretted hydrogen, the alcohols being regenerated.† In this way Mr. Hofmann succeeded in forming from the alkaloid, amylic alcohol. As the transformations of organic substances furnish us with the means of obtaining the corresponding bases, the problem of obtaining the alcohols of the propionic and butyric series is solved.

The reaction which gives rise to nitrous ether is not clearly explained; the nitrite obtained by double decomposition will be C_2H_7N, NHO_2, and may be resolved into $N_2+H_2O+C_2H_6O$. The simultaneous evolution of nitrogen gas and nitrous ether, or indeed the formation of the latter, can only be explained by some secondary action which it is not easy to foresee. We hope for more definite information upon the subject.

A curious subject of inquiry presents itself in regard to those bases which contain two and three equivalents of the alcoholic elements. If the decomposition were to take place in accordance with the formula above given, nitrate of biethylamine would yield $C_4H_{10}O$, which is the ether of alcohol, or its isomere butyric alcohol, and triethylamine, $C_6H_{14}O$, which is the formula of caproic alcohol. The decomposition of all the complex alkaloids by this reaction will be of great interest.

Montreal, C. E., Nov. 10th, 1851.

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* This Journal, vol. iv, p. 350.

ART. XVII.—*The Pendulum Experiment;* by Lieut. D. P. WOODBURY, U. S. Corps of Engineers.

WITH the exception of some unimportant allusions to the labors or suggestions of others the following article was drawn up in June last. It is an attempt to present the subject in a simple light, and to furnish a demonstration at once rigorous and easily intelligible. No allusion is made to those disturbing causes which we can either avoid or suppose to be avoided when the experiments are made in the most perfect manner.*

It is easy to understand the phenomena of the Foucault problem when the experiment is supposed to be tried at the pole of the earth or on the equator, but the case becomes more complex when the experiment is made at any intermediate point.

I will explain briefly the mechanical principles involved in this problem and then propose a new experiment analogous to that of the pendulum.

Let us suppose a piece of iron, or any heavy substance, which, for convenience, we will call a needle, suspended, in a horizontal position, in a north and south line, by a thread or wire. The needle will continue in the meridian for any period of time, and in so doing its prolongation must always pass through the same point on the prolongation of the axis of the earth. Around that point in each instant of time, it describes a small angle on the surface of the cone. The amount of that angular velocity, as compared with that of the earth during the same period, is easily calculated, either by comparison of the elementary arcs, or by the development of the cone and the comparison of the whole angular motion of the needle during a revolution of the earth with the corresponding motion of the earth or 360.° In either way we find

Angular motion of needle $=$ angular motion of the earth $\times$ sine of latitude.

If the needle be suspended horizontally in any direction inclined to the meridian it will always maintain the same inclination and will therefore always maintain, on the surface of the cone, the angular velocity of the meridian as given above.

Now let us enquire under what influence or power the meridian needle moves, with uniform velocity, around the vertex of the cone. It is because every point of it has the motion of rotation round the axis of the earth due to its distance from that axis, and it moves as part of the earth. The *difference* between the velocity of the center and the velocity of the other parts is the cause of its angular motion on the surface of the cone.

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* For other articles in this Journal on this subject, see last volume, pp. 200, 251, 398.

A power applied to the center of gravity of any body has no effect on its angular velocity. If therefore in this rotation around the axis of the earth, the center of the needle were stopped while every other point of it retained a velocity equal to the difference between its former velocity and that of the center, the needle would continue to move, round a vertical line, with the same angular motion which it before maintained around the vertex of the cone.

Let us now suppose a second needle, which, during a revolution of the earth, has the same absolute velocity at every point, viz.: that due to its center. It was the difference in velocities that caused the angular movement of the first needle. But we have by supposition restored that difference. We have applied, as it were, to the first needle, in an opposite direction, the precise power which caused its own angular movement. So that if we take the first needle or meridian as the line of comparison, the second must continue to move from it with a uniform angular velocity equal to that of the first around the vertex of the cone.

But we may view the phenomena in another and perhaps more simple light.

The second needle, supposed to start on the meridian, with equal velocities at all points, will no longer continue on the meridian. The north end will continually make to the east of it, and the south end fall equally to the west of that line. The center is compelled to move on the parallel of latitude, and every point of the needle, having the same velocity, must move over the same distance, and this it can only do, when, in every instant of time, all the points describe equal and parallel lines—the rate of the motion being constant, viz.: that of the center—the direction constantly varying with that of the center. It follows that the needle must continue equidistant at all points from its first position supposing distances to be measured on the surface of the cone. Let us now, after the manner of Lieut. Hunt in his elegant geometrical solution of the problem published in the National Intelligencer, develop the cone on the tangent plane through one of its elements—say the one corresponding to the first position of the needle. All the positions of the needle become parallel—the several points continuing on equal though not concentric arcs: and at every point, the angle between the needle and the corresponding meridian line, is equal to the angle between the latter and the first meridian, or the sum of the angles described between the two around the vertex of the cone.

The pendulum, after a few oscillations, is precisely in the situation of the second needle. Whatever motion of rotation it may have, that motion is kept up equally on both sides of the central point, so that the ball may be regarded as having throughout the motion due to its central position alone. The motion of its plane has therefore been accounted for. It is now evident that the Foucault problem admits of some extension.

1. Let us suppose a continuous hollow ring filled with water or some other fluid, the heavier the better, and suspended symmetrically in a vertical plane by a proper cord. Let the fluid be kept in continual circulation by means of a lamp attached to one side of the ring. Then will the ring revolve precisely like the plane of the pendulum and for the same reason:—because the suspended mass is compelled to be equally on both sides of the vertical axis or suspending cord. The rotation of the ring however must be somewhat retarded by the material of the ring, lamp, &c., which do not partake of the motion of the fluid.

2. Let a similar ring be placed symmetrically upon a small inflexible axis parallel to the axis of the earth, and let the fluid be kept in circulation as above. The ring will rotate no longer with the pendulum of our latitude, but with the pendulum at the pole of the earth, or once in twenty-four hours.

Again let the axis of the ring receive any direction, the velocity of rotation will be that of the pendulum at the place whose vertical line is parallel to that direction, or equally inclined with it to the axis of the earth.

3. Instead of a hollow ring let us suppose a solid ring or plate made to revolve round an axis at right angles to its plane by some attached machinery while the whole is supported symmetrically, by a vertical cord or axis, or by an axis inclined, as above, around which it is free to move. The result will be the same as in 1 and 2.

It would seem therefore that the Foucault experiment for all latitudes may be illustrated at any place, but it must be admitted that there are many practical difficulties to overcome—particularly when the principal axis is not vertical. These suggestions are thrown out for those who have the leisure, the means and the taste for such pursuits.

Some have supposed that any horizontal plate or bar, suspended by a cord, would continue to revolve like the plane of the pendulum if the proper motion could once be communicated—forgetting that the retarding force of friction, which is always acting, must soon destroy the motion communicated by an *impulse*. If all friction could be destroyed the bar would indeed maintain *any* rate of motion once communicated to it.

It has been suggested that the proper motion would be communicated to a suspended bar if its two ends were suddenly reversed and then allowed to move with the velocities previously acquired. The motion thus communicated would be *double* the one desired. The proper motion is communicated by the pendulum or by the means described above. To keep that motion up and overcome the friction always acting, the power must be continually renewed.

ART. XVIII.—*Peculiarities of the Climate, Flora, and Fauna of the South Shore of Lake Erie, in the vicinity of Cleveland, Ohio;* by J. P. KIRTLAND.

VERY erroneous opinions are entertained by even intelligent people, respecting this section of country, so far as its climate and the species of the animal and vegetable kingdoms are concerned. A series of observations, embracing a period of ten years, have disclosed some interesting facts upon these points.

The locality where these observations were made, is situated five miles west of Cleveland, half a mile from the lake, one hundred and fifty feet above its surface, and fully exposed to its influence. During the ten years, the temperature has in no instance fallen below zero; while at Columbus, Marietta and Cincinnati, situated from 120 to 150 miles to the south, it has frequently sunk to 5°, and has occasionally fallen to 10°, at some of those places. Their latitudes are as follows, to wit:

Point of observation near Cleveland,

North, ...	41° 31′
Columbus, ...	39° 57′
Marietta, ...	39°
Cincinnati, ...	39° 5′ 54″

The more tender vegetation is usually cut down in all northern Ohio—a few localities excepted—within five days of the 25th of September. The lake shore is an exception. Dahlias, maize, and sweet potatoes are generally killed simultaneously here, and at Cincinnati—never before the 25th of October, and sometimes not until late in November. In one instance, at least, the lake shore escaped two weeks later than did Cincinnati.

At the present moment, October 25, vegetation is as verdant and thrifty as it has been at any time during autumn, though it was cut down throughout the West generally several weeks since.

The foliage of the fruit and forest trees, having subserved its purposes, is falling without the intervention of frost, and the wood of the more tender trees, such as the peach and cherry, has attained a maturity that will render it sufficiently hardy to withstand the impressions of cold during winter. This occurring annually, gives to those trees a degree of vigor, health and productiveness not to be met with in localities where their growth is suddenly arrested by frost, at a period when they are immature.

In the middle and southern sections of Ohio, spring sets in during the month of March—perhaps earlier. The warm winds blowing up the valleys of the Mississippi and Ohio, in conjunction with other causes, bring forth vegetation earlier; but cold weather and disastrous frosts too often follow.

While these changes are progressing in those parts of the state, winter will remain steadfast at this point. Little advancement will be made by spring, so long as any considerable bodies of ice float upon the lake, even as low down as Buffalo. No sooner do they disappear than spring sets in with a reality, and vegetation puts forth with *sub-arctic* rapidity.

The lake rapidly imbibing heat at this season, becomes a safeguard against any subsequent vernal frost. Its influence was manifested in a satisfactory manner, early in the present season. On the 1st of May, spring seemed to be fully established; fruit trees had blossomed, and in some localities young fruits had formed. The morning was cold and the temperature declined during the day and evening. At 2 o'clock, P. M., it was 48° Fahrenheit; at 7, 34°; and at 9, 32°. The atmosphere was calm and clear, indicating to an inexperienced observer the approach of a destructive frost. At 10 o'clock, P. M., it had risen to 40°; a heavy cloud of haze hung about twenty degrees above the lake, and soon overspread the whole horizon. The morning of the following day was warm and misty; by 12 o'clock, A. M., it was clear and spring-like. Not a fruit-germ was injured on the lake shore. A different state of things occurred throughout the West and Southwest, where no local influences interposed. The temperature steadily declined, without intermission, during the day and night, down to about 26°. The day following was cold and blighting, and fruits were generally destroyed.

The modes by which the lake exerts its influence on such occasions do not appear to be uniformly the same at different times.

On the approach of a cold night, as in the instance above noticed, the warm emanations condensing may give off caloric, and obscure the atmosphere with haze, mist, or clouds, when no frost will occur.

Under circumstances apparently similar, on the approach of a cold night, neither haze mist nor clouds may form, but a stiff breeze springs up, and the stars become unusually brilliant. The thermometer vacillates between 32° and 38°, rising with the gusts of wind, and falling during the intervals of calm. *Then* no frost will appear.

Again, none of those modifying causes may intervene, but the temperature may fall below freezing point, ice form on the surface of water, and the expanded fruit, leaves and blossoms congeal. Under such circumstances, the first rays of the rising sun, the next morning, will be arrested by a haze, which will soon thicken, and before noon a warm rain will probably fall. The frost will be abstracted so gradually from frozen vegetation as not to impair its vitality.

These contingencies have all occurred within the period of our observations. The year 1834 proved an exception.—The general cold prevailed over the local warmth of the lake; freezing weather continued two or three days, and fruits were cut off, even on the shore of the lake.

In autumn, this great body of water begins to part with its warmth to the colder incumbent atmosphere, and the process continues during the winter. While its progress is most rapid, strong southerly winds prevail at the earth's surface, while volumes of clouds, at a high elevation, may at the same time be moving rapidly in an opposite direction.

These counter-currents have sometimes given origin to a phenomenon in the city of Cleveland, not well understood by all of its good citizens. The vane of the lofty spire of the Baptist church, standing on a high ridge of ground, may point steadily to the north, while that on the low cupola of the First Presbyterian church, situated on a less elevated plateau, may be directed to an opposite point of compass, with a stiff southerly breeze at the same time.

Cool north winds begin to prevail about the middle of October. The emanations from the lake then begin to condense and pass off to the south, in the form of thick clouds, without discharging, at first, much rain. About the 20th of October the cold from the north seems to gain the ascendancy; squalls of rain, hail, and rounded snow appear alternately, with intervals of clear and warm weather. These squalls always precede the autumnal frosts. Our gardeners feel no apprehension for their tender vegetables till these premonitions have appeared.

Common observations, as well as the more sure test, the rain-guage, show that larger amounts of vapor from the lake are carried south, condensed in the form of rain and snow, than fall in this vicinity.

During winter comparatively little snow falls, and still less accumulates here, though it may be abundant on the higher grounds, thirty or forty miles in the interior.

This region is also not so frequently favored with showers in summer as the central portion of the state. Long and severe droughts often prevail, but they are in part counteracted by moisture in the atmosphere. This quality sustains vegetation, and also imparts a blandness and freshness to the atmosphere during the hottest days of summer, very observable on approaching the lake from the interior. During that season it is peculiarly pleasant and invigorating to invalids, and equally harrassing to them during the spring season.

The indigenous vegetation of this vicinity is of rather a southern type—shown by the absence, in a great measure, of evergreens, and the occurrence of more southern genera, as the Cercis, Ilex, Æsculus, Nelumbium, Gleditschia, Magnolia, &c. Eliott's Botany of South Carolina and Georgia has been found to be a convenient hand-book for investigating our flora. On the other hand, strange hyperborean plants are frequently found, which have been washed down from the far Northwest, through the chain of great lakes.

Many of our birds are species whose most northern ranges of migration have been assigned many degrees south of this, by ornithologists. The hooded, Kentucky, yellow-throated-wood, cœrulean, and prairie warblers, annually rear their young in this vicinity. Trail's fly-catcher, and the piping plover, have been repeatedly seen here, and the purple ibis is an occasional visitor. The list might be greatly extended.

Great numbers of the Sylvicolæ semi-annually congregate here, during their migrations, and seem to make it a resting-place, both before and after passing the lake. More northern species occasionally resort here during winter, for the purpose of obtaining food, or are driven here by storms: such are the pine-grosbeak and the white owl. The Bohemian wax-wing visits us almost every winter, and sometimes in large flocks. The pinefinch is described, by some ornithologists, as resorting to the United States only at long intervals, and during winter. It visits our gardens and grounds in numerous flocks, every season, early in July, and remains here till the ensuing spring.—The young, at their first appearance, still retain much down about their plumage, and cannot have been long absent from their nests. The food of these birds is Aphides during summer, and at other times small seeds of grapes, and other vegetables.

The insect tribes show still more strikingly southern affinities. The Papilio Cresphontes, figured and described by Boisduval and Le Conte, as the ***Papilio Thoas***, has been repeatedly taken here; though it has been considered as exclusively southern in its resorts. In the South, the larva feeds on the orange and lemon—here, Major Le Conte informs me, it lives on the Hercules-club.

The Papilio Ajax and P. Marcellus have also been described as southern insects; and the late Mr. Doubleday located the former exclusively in Florida, and fixed the most northern limit of the latter in Virginia. Still they are common at this point, and subsist in the larva state, on the pawpaw. An undescribed species of Libythea has been taken in Northern Ohio; it has been found, also, in South Carolina, and is without doubt legitimately a Southern species.*

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* See the figure and description in No. 76 of the Family Visitor.

The Chœrocampa tersa, an elegant miller, was taken in our garden, in the month of May last. Dr. Harris describes it as a native of South Carolina, where it feeds on a species of plant which does not grow at the North.* The food it finds as a substitute, has not been ascertained.

Art. XIX.—*Analysis of a Magnetic Iron Pyrites, containing Nickel, from Gap Mine, Lancaster Co., Pennsylvania;* by M. H. Boye, Professor of Chemistry and Natural Philosophy, Central High School, Philadelphia.

Description.—Color, dark gray drawing into bronze; lustre metallic; texture, granular interspersed in some places with copper pyrites, hornblende and black mica. Powder dark greenish; streak black. Attracted by the magnet, and possessing distinct magnetic polarity. Specific gravity of the whole piece (including interspersed gangue,) 4·193. Somewhat porous and easily broken.

1. Five grammes of finely pulverized ore were digested with strong nitric acid with addition of chlorohydric until the separated sulphur had assumed a perfectly yellow color. It was then diluted with some water and filtered. The residue was washed, dried and incinerated, yielding, after deduction of the ashes of the filter, *silica and insoluble silicates* 1·273 grammes, or 25·46 *per cent.*

2. The filtered solution from the silica (§1) was precipitated in cold by carbonate of lime (whiting) previously triturated with water, till after standing for twenty-four hours it showed still a film of fine undecomposed carbonate of lime floating on the top of it. The precipitate was then separated by filtration and washed moderately with water. The filtered solution, after being acidulated, yielded no precipitate by sulphohydric acid.

3. By the addition of ammonia in slight excess to the above, it yielded a black precipitate of sulphuret of nickel. The passage of sulphohydric acid was then continued through it for some time, by which the sulphuret of nickel settled to the bottom, and the supernatant solution became clear, and of a light yellow color, indicating no nickel in solution. The sulphuret of nickel was then filtered and washed; the filtered solution being rejected for further use.

4. The precipitate obtained by carbonate of lime (§ 2) was redissolved in chlorohydric acid, filtered from the separated silica

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* See Dr. Harris's very valuable Catalogue of American Sphinges, in vol. xxxvi, Amer. Journal of Science and Arts. The student of Entomology will there find the history of this intricate family made plain by the labors of Dr. H.

(from the whiting) and sulphohydric acid passed through it to saturation. The precipitate, containing much free sulphur, was filtered, washed and digested with sulphohydrate of ammonium. A black precipitate remained, which after washing was oxydized by nitric acid, filtered and precipitated by hydrate of potassa after addition of some ammonia, and thus after filtering, washing, drying and incinerating, yielded oxyd of copper 0·075 grammes, or 1·50 per cent., equivalent to 1·197 *per cent. metallic copper.*

5. The filtered potassic solution from the oxyd of copper (§ 4) became dark by the addition of a few drops of sulphohydrate of ammonia and deposited a black precipitate, which, collected in a counterpoised filter and dried in water-bath, weighed 0·019 grammes or 0·38 per cent. This, dissolved in diluted nitric acid, yieded by addition of diluted sulphuric acid an abundant precipitate of sulphate of lead. The filtered solution from this yielded, by a current of sulphohydric acid, an inconsiderable amount of sulphuret of copper amounting to 0·003 grammes or 0·06 per cent., equivalent to 0·04 *per cent. metallic copper.* The above 0·38 per cent. contained, therefore, after deduction of the sulphuret of copper 0·32 per cent. sulphuret of lead, equivalent to 0·27 *per cent. metallic lead.*

6. The filtered solution obtained from the above sulphurets by digestion with sulphohydrate of ammonium (§ 4) was acidulated with chlorohydric acid and yielded an abundant precipitate of the usual appearance of precipitated sulphur which was filtered and washed. It contained neither antimony nor arsenic but left by gentle heating 0·005 grammes or 0·1 per cent. of sulphuret of copper, equivalent to 0·066 *per cent. metallic copper.*

7. The main solution from § 4, after the passage of sulphohydric acid through it and filtration of the separated sulphurets, was evaporated to a smaller volume and then boiled with the addition of nitric acid, for the conversion of monoxyd of iron into sesquioxyd. The latter was then again precipitated as in the first instance by carbonate of lime, filtered and washed. The filtered solution was mixed with ammonia in very slight excess and sulphohydric acid passed through it until it settled clear. It thus yielded a second precipitate of sulphuret of nickel which was separated by filtration, washed and added to that of § 3.

8. The last filtered solution (§ 7) from the sulphuret of nickel was of a clear but strong yellow color. By standing for several days it deposited a precipitate of sulphuret of nickel, was filtered, washed and strongly incinerated, yielding 0·002 grammes or 0·04 per cent. which calculated as oxyd is equivalent to 0·032 *per cent. metallic nickel.*

9. The sulphurets of nickel (§ 3 and 7) were oxydized by nitric acid with the addition of chlorohydric, till the sulphur became perfectly yellow. The solution was filtered and mixed

with ammonia in great excess, by which a small portion of sesquioxyd of iron precipitated, which was separated by filtration. The filtered ammoniacal solution was then mixed in a capsule with carbonate of soda in excess, evaporated to dryness and heated till it changed its color. It was then re-dissolved in boiling water and filtered. The filtered solution contained no trace of nickel. The precipitate was washed, dried, incinerated and weighed, yielding monoxyd of nickel 0·287 grammes or 5·74 per cent. equivalent to 4·517 *per cent. metallic nickel.* The oxyd of nickel contained neither cobalt nor manganese.

10. To estimate the amount of iron, one gramme of the ore was digested as before in nitro-muriatic acid. The filtered solution was precipitated with ammonia in great excess. The precipitated sesquioxyd of iron was filtered and washed with ammonia and then digested with hydrate of potassa, again filtered, washed, re-dissolved in chlorohydric acid and precipitated by ammonia, filtered, washed, dried and incinerated, yielding 0·618 or 61·3 per cent., which after deduction of the contained oxyd of nickel (see § 16) leaves 59·62 equivalent to 41·34 metallic iron.

11. The potassic solution from the digestion of the sesquioxyd of iron was super-saturated with nitric acid and precipitated by ammonia by which it yielded a precipitate of alumina amounting to 0·017 grammes or 1·70 per cent.

12. The solution from § 10 was acidulated by chlorohydric acid, and then sulphohydric acid passed through it until saturated. The precipitate was separated by filtration, the filtered solution slightly super-saturated with ammonia, and sulpho-hydric acid passed through it until the sulphuret of nickel settled clear. The latter was filtered, dissolved in nitro-muriatic acid, filtered, evaporated to dryness with carbonate of soda in excess, heated, re-dissolved in boiling water, filtered, washed and incinerated, and yielded 0·041 grammes or 4·1 per cent. oxyd of nickel, equivalent to 3·15 *per cent. metallic nickel.* The filtered solution contained no nickel.

13. The solution filtered from the sulphuret of nickel was barely neutralized by chlorohydric acid and evaporated at a low temperature to a smaller volume. The separated sulphur had a dark grayish color and was therefore separated by filtration and incinerated with the sulphur from the oxydation of the sulphuret of nickel (§ 12) but amounted to no appreciable quantity.

14. The filtered solution (§ 13) indicated by the addition of ammonia and oxalate of ammonia only a trace of lime. After filtration the addition of phosphate of soda caused no precipitate.

15. To determine the quantity of sulphur, one gramme of the finely pulverized ore was mixed with five grammes of nitre and the same amount of carbonate of soda and heated to beginning fusion in a platinum crucible. The mass was digested with

water and filtered. The solution was super-saturated with nitric acid and precipitated lukewarm by chlorid of barium. The sulphate of baryta was filtered, washed with boiling water, dried and incinerated, weighing 1·800 grammes, equivalent to 24·84 per cent. of sulphur.

16. Deducting the difference of oxyd of nickel in the two experiments (§ 8, 9 and 12) from the amount of oxyd of iron (§ 10) the analysis will stand thus:

	In 100 parts.
Iron,	41·34
Nickel,	4·55
Copper,	1·30
Lead,	0·27
Sulphur,	24·84
Silica and insol. silicates,	25·46
Alumina,	1·70
	99·46

17. After deducting the sulphur necessary for the conversion of the lead (0·04) and the nickel (2·47) into sulphurets, and the sulphur (1·32) and iron (1·15) necessary to form with the copper, copper pyrites, there remains 21·01 sulphur, for 40·19 iron. The latter would require for its conversion into monosulphuret, 23·25 sulphur. A small portion of the iron may however be due to the gangue.

ART. XX.—*On the "Clinochlore" of Chester Co., Pa.*; by Mr. W. J. CRAW, First Assistant in the Yale Analytical Laboratory.

THE optical and blowpipe characters of this mineral were described by Mr. Wm. P. Blake in the American Journal of Science, 2nd Series, vol. xii, p. 339; also vol. xiii, p. 116.

The remarkable results which he obtained by examination with polarized light have led to my undertaking a complete analysis of the mineral, in order to ascertain whether it differed or not in chemical constitution from chlorite. Qualitative analysis gave as the constituents, $\dddot{Si}$, $\dddot{\bar{Al}}$, $\dddot{\bar{Fe}}$, $\dddot{\bar{Cr}}$, $\dot{Mg}$, and $\dot{H}$ with a trace of $\dot{Ca}$. Protoxyd of iron was tested for, but none could be detected.

Two analyses of the mineral were made. In the first, it was fused with carbonate of soda, dissolved in dilute nitric acid, and evaporated to dryness to separate silica in the usual manner. To the solution in hydrochloric acid filtered from the silica, alcohol was added, and the whole heated for some time in order to reduce the chromic acid to the state of oxyd. The alumina, peroxyd of iron, and oxyd of chromium were then precipitated together by carbonate of baryta, redissolved in hydrochloric acid, and, after removal of the baryta by sulphuric acid, again precipitated by ammonia. The mixed oxyds were ignited, weighed, and fused with carbonate of soda and nitre. From the solution in nitric acid the iron and alumina were precipitated by ammonia, and afterwards separated by caustic potash; the chromium was determined in the filtrate.

From the solution filtered from the precipitate by carbonate of baryta, the dissolved baryta was removed by addition of sulphuric acid, and the magnesia then precipitated by phosphate of soda. The second analysis was conducted in a manner similar to the first, except that the iron, alumina, and chromium were weighed together, and not separated from each other. Two determinations were made of the water, giving, respectively, 12·631 and 12·567 per cent.; mean = 12·599.

The results were the following; in calculating the proportion of oxygen from the second analysis, the amount of iron and chromium found in the other analysis was deducted from the joint amount of the peroxyds, and the remainder assumed to be alumina.

	I.	II.	Oxygen in I.		In II.	Mean.
$\dddot{Si}$	31·344	31·78	16·284		16·513	16·40
$\overline{Al}$	17·467	22·71	8·164	8·025	9·709	9·78
$\overline{Fe}$	3·855		1·156	9·848–1·156		
$\ddot{Cr}$	1·686		0·528	0·528		
$\dot{Mg}$	33·44	33·64	13·376		13·456	13·42
$\dot{H}$	12·599	12·599	11·19		11·19	11·19
	100·391	100·729				

Ratio between the oxygen of the silica, peroxyds, magnesia and water = 1·677 : 1 : 1·372 : 1·144 or 15 : 9 : 12 : 10 nearly. This ratio is the same as that calculated by Rammelsberg, (2d Supplement, p. 36,) from the mean of seven analyses of chlorite. He changes the proportion to 15 : 9 : 12 : 9 on the ground that hygroscopic moisture is always contained in the analyzed mineral.

This would give as the formula either,

$$\dot{Mg}^3 \dddot{Si}^2 + 3\overline{R} \dddot{Si} + 9\dot{Mg} \dot{H},$$
$$\text{or} \quad 2\dot{Mg}^3 \dddot{Si} + 3\overline{R} \dddot{Si} + 3\dot{Mg}^2 \dot{H}^3,$$

to the latter of which Rammelsberg gives the preference.

According to Gerhardt's theory, who considers the protoxyds, peroxyds and water as replacing one another, this will come under that class of minerals, in which the oxygen of the silica is to that of the other constituents in the proportion of 1 to 2. Chemically considered, the only difference between the Clinochlore examined and the ordinary chlorite appears to consist in the fact that the former contains chromium. It is, however, as has been shown by Mr. Blake, widely different in its optical properties.

Art. XXI.—*Phosphoric Acid in Normal Human Urine;* by Dr. D. Breed.

Notwithstanding the importance of all knowledge appertaining to physiology and pathology, neither chemist nor physician has heretofore made any considerable research in relation to phosphoric acid in urine. But the accurate and expeditious method for the determination of phosphoric acid, proposed by Professor Liebig, forbids our remaining longer in ignorance of facts which may be of great value in the treatment of disease. This method consists simply in the titrition of urine, with a solution of the perchlorid of iron, until the filtrate from the mixture gives the well known blue reaction with ferrocyanid of potassium. It is based upon the fact that either a neutral or acetic acid solution of phosphoric acid gives with perchlorid of iron an insoluble precipitate, whilst the peroxyd of iron is readily dissolved by acetic acid. If a solution of phosphoric acid containing acetate of soda be treated with perchlorid of iron, we have the following reaction—$PO_5+3(NaO,\bar{A})+Fe_2Cl_3=Fe_2O_3,PO_5+3(NaCl)+3\bar{A}$.

The solution of perchlorid of iron is most conveniently made by dissolving in nitro-hydrochloric acid 15·656 grammes of iron, and evaporating to dryness, to expel the excess of acid, then adding nitric acid, and again evaporating to prevent the existence of protochlorid, and afterward, re-dissolving the product in 2000 cc. of water. Every cc. of this solution will precipitate ten milligrammes of phosphoric acid. Instead of the above, a solution of the perchlorid of iron of unknown strength may be used, and the iron be determined. Or, the strength of the solution of iron may be found by titrition with a solution of phosphoric acid of known strength. In all the above methods the solution of iron must be free from proto-chlorid.

If the urine, of which we would determine the phosphoric acid, has become alkaline by the decomposition of urea, some of the phosphoric acid may have been precipitated with lime or magnesia, and it will be necessary to dissolve the precipitate by a few drops of hydrochloric acid. The urine is measured and shaken well; with a pipette 100 cc. or more are drawn off into a beaker glass; acetate of soda (much if hydrochloric acid has been used) and free acetic acid are added. The urine is then treated with a solution of perchlorid of iron from a burette,—frequently testing, until the phosphoric acid is saturated, and we have a drop of iron in excess. To test for iron in excess, lay a filter on a white porcelain plate, or on a glass supported by white paper, and moisten it slightly with ferrocyanid of potassium; with a glass rod bearing a drop of urine, press a double filter upon the paper containing the ferrocyanid of potassium, and if there be an excess of iron, in three or four seconds we have the blue reaction: noting the quantity of the solution of perchlorid of iron used, we proceed in like manner with two other portions of urine; if the results agree, we then calculate the amount of the solution of iron required for all the urine from what was found necessary in 100 cc. and multiplying the number of cc. required in all, by the amount of phosphoric acid known to correspond to one cc. of the iron, we have the amount of phosphoric acid in the whole urine. By this method, a physician who has but little leisure, may make each day many determinations of phosphoric acid.

The amount of phosphoric acid from an individual in health, and partaking of a uniform diet, is nearly uniform; but experiments now being made, show that diet, disease, and medicines vary the amount of phosphoric acid from the normal standard. These considerations, whilst they show the necessity of a more extensive and varied course of experiments, indicate that farther research may lead to discoveries in regard to the constituents of urine which may be of the highest importance in therapeutics. Prout, Bright and others have but opened a field of labor and discovery upon which the chemist is earnestly called to enter. Numerous statistics in regard to normal urine from individuals of different temperaments and modes of living, are first necessary. Pathologists must critically observe the effects of various maladies upon the urine,* and then we shall have the data whence to reason, and possibly to discover, not only the causes and cure of calculus without the use of the surgeon's knife, but light also may be thrown upon the treatment of many other diseases which now baffle the skill of the physician.

Determinations of Phosphoric acid in Urine.

The following results were obtained from the urine of four persons, mostly from that of one person.

Urine of 24 hours.	Phosphoric acid.	Urine of 24 hours.	Phosphoric acid.
1645 cc.	2·118 grms.	1607 cc.	3·931 grms.
1150	2·909	2075	4·336
1690	3·454	1208	2·719
1675	2·611	1640	2·837
1462	3·647	2655	6·051
1462	3·647	1777	5·126
†1707	3·744	2058	3·888
†1707	3·744	1768	3·407
†1701	6·447	985	3·384
†1701	6·447	1561	3·941
†1380	2·862	1916	4·946
†1380	2·862	740	2·523

Average { 1000 cc. gives 2·317 grms. phosphoric acid.
24 hours gives 1610 cc. urine, and 3·732 grms. phosphoric acid.

* Dr. Breed has discovered phosphoric acid in a fluid which Professor Vogel of Giessen obtained by the operation of paracentisis abdominis. From 3105 cc. of the fluid, 4,648 grammes of phosphoric acid were obtained. In the urine of this patient during twenty-four hours, only 1·2 grammes of phosphoric acid were found.

† Average of two days.

Results from a person who drank an excess of three pints of water daily.

Urine of 24 hours.	Phosphoric acid.
2470 cc.	4·288 grms.
2407	4·274
1548	4·006
1919	4·344

Average { In 1000 cc. of urine, 2·027 grms. phosphoric acid.
" 24 hours 2086 cc. urine and 4·228 " "

Results from a person who drank but half his usual amount of fluid.

Urine of 24 hours.	Phosphoric acid.
787	3·807
1220	4·218
950	3·904
997	4·133

Average { In 1000 cc. of urine, 4·062 grms. phosphoric acid.
" 24 hours 988 " 4·015 " " "

Results from urine secreted during the waking hours, and during those of sleep.

Night. Urine.	Phosphoric acid.	*Day.* Urine.	Phosphoric acid.
627 cc.	1·472 grms.	835	2·174
627	1·472	835	2·174
650	1·169	1057	2·575
650	1·169	1058	2·576
671	2·385	1030	4·061
671	2·385	1030	4·062
635	·999	745	1·904
635	·999	745	1·904
980	1·611	1078	2·277
540	1·033	1236	2·374
360	1·258	625	2·127
450	1·223	765	2·367
325	·634	1103	2·718
325	·634	1454	4·019
462	·927	555	1·796
185	·528		
415	1·364		

Av'age { In 1000 cc. urine, 2·763 grms. phos. acid.
" 24 hours 1748 cc. urine & 4·831 phos. acid.

Av'age { In 1000 cc. urine, 2·284 grms. phosphoric acid.
" 24 hours 1854 cc. urine, and 4·234 grms. phosphoric acid.

Results from a person who drank an excess of water.

Night. Urine.	Phosphoric acid.	*Day.* Urine.	Phosphoric acid.
1050	1·351	1420	2·936
910	1·496	1497	2·781
230	·827	1318	3·179
435	·934	1484	3·410

Av.–In 1000 cc. urine, 1·755 grms. phos. acid. Av.–In 1000 cc. urine, 2·130 phos. acid.

Results from a person who drank very little.

Night. Urine.	Phosphoric acid.	*Day.* Urine.	Phosphoric acid.
245	1·132	542	2·674
377	1·549	843	2·668
435	·983	...	....
382	1·516	615	2·617

Av.–In 1000 cc. of urine, 3·599 grms. phos. acid. Av.–In 1000 cc. urine, 3·979 phos. acid.

Results from urine secreted before and after dinner, exclusive of the hours of sleep.

Before dinner. Urine.	Phosphoric acid.	*After dinner.* Urine.	Phosphoric acid.
360	·995	260	·908
360	·995	260	·908
815	1·377	263	·901
919	1·510	317	·863
405	1·415	220	·712
585	1·595	180	·772
803	1·485	300	1·233
612	1·510	492	2·174
613	1·510	310	1·274
962	1·845		
245	·722		

After dinner: Av'age { 1000 cc. urine, 3·745 grammes phos. acid. 24 hours 1120 cc. urine, & 4·881 grms. " "

Before dinner: Av'age { 1000 cc. urine, 2·239 grammes phos. acid. 24 hours 1418 cc. urine, 3·177 grammes phos. acid.

Results from a person who drank excess of water.

Before dinner. Urine.	Phosphoric acid.	*After dinner.* Urine.	Phosphoric acid.
960	1·447	460	1·490
1212	1·826	280	·955
363	1·164	955	2·011
1004	1·733	480	1·678

Before dinner: Av'age { 1000 cc. urine, 1·743 grms. phosphoric acid.

After dinner: Av'age { 1000 cc. of urine, 2·820 grms. of phosphoric acid.

Results from a person who drank very little.

Before dinner. Urine.	Phosphoric acid.	*After dinner.* Urine.	Phosphoric acid.
360	1·627	182	1·047
620	1·751	223	·916
560	1·473	385	1·725
230	·891		

Before dinner: Av'age { 1000 cc. of urine, 3·244 grms. phosphoric acid.

After dinner: Av'age { 1000 cc. urine, 4·541 grms. of phosphoric acid.

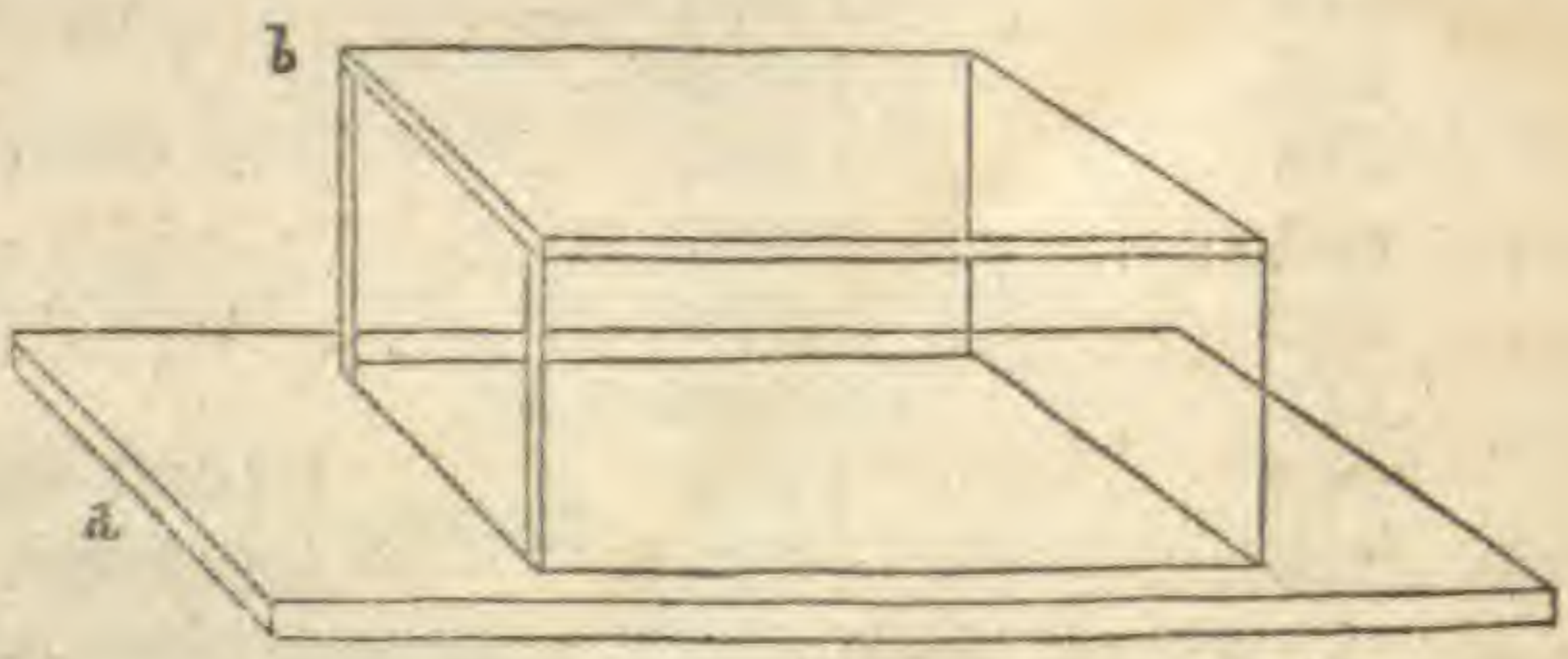
Art. XXII.—*Instructions for making wet Preparations of Animal Substances;* by Henry Goadby, M.D., F.L.S., formerly Dissector of Minute Anatomy to the Royal College of Surgeons of England.

There are many preparations of entire animals no less than dissected portions of them, which can be well displayed only in vessels with flat surfaces, in contradistinction to round or oval bottles; but, from their greater size, they cannot be displayed in vessels constructed on the principle of those already described. For all such, I build up a *box* of glass, consisting of four sides, the bottom plate (or slide) and the top, or cover.

These vessels are confessedly difficult to make; yet they form the most attractive and beautiful exhibitions that can be put into a museum. The trouble I have had with these upright vessels, no less than my great desire to submit them and the preserving fluids, to the only satisfactory test—time, has retarded the publication, on my part, of the several processes herein referred to.

Having settled the length, depth, and width for an upright box, the glass for the sides should be selected of sufficient substance for the bulk and weight of fluid the vessel is destined to contain; and it will frequently happen that the ends (by which I mean the two lengths of *least diameter*, calling the larger and outer portions the sides, as in the annexed figure, 9,) require to be somewhat thicker than the sides to insure sufficient surface for a joint. The glass should be cut as true and square as possible in the first instance; the two side pieces and the two end pieces should be connected together, respectively, with the marine glue, forming two pairs of glasses. First, bevel all the outer edges, of all the glasses, on the metal plate, as before directed; and then proceed to make perfectly flat the extreme ends of each pair of glasses; this, the most important, is, at the same time the most difficult part of the work, and such as can be accomplished only by practice; the position of the glass in the hand must be frequently changed, for the pressure of two fingers on one side, opposed to the thumb on the other, will have a tendency to incline the glass to an angle of 45°, whilst the operator believes he is holding it perfectly upright. It frequently saves time to grind till a smooth but inclined surface extend from one outer edge of the pair of glasses to the other, and then change its position in the hand—the probability is, that there will be the like tendency to form a similar angle, although reversed, and by carefully watching and measuring, the operation may be suspended at the point where perfect flatness obtains, and just before the inclined plane can be formed in the other direction. A small brass square will be found of considerable importance in testing the truth of the grinding, but the most severe test is that which I always resort to, namely, to wet the ground surface of glass as lightly as possible and place on it a plate of plate-glass—the sides of which, for all practical purposes, are parallel: if true and flat, the plate-glass will be seen to touch every part of the ground surface and form with it a ⊤. Now, wipe all the glass just tested quite dry; *breathe* upon the ground surface, and quickly apply the plate-glass—if pure, the moisture of the breath will be equally diffused along its surface, and the contact be so perfect that the ground surface will hang suspended for several seconds from the plate-glass. If the work endure this test, there need be no doubt about making a permanent joint.

9.



Again use the iron-plate, un-cement and clean the glasses, prepare the ground surfaces of the ends and the flat surfaces of the sides against which the ends are to abut, with the naphtha solution; return all the glass to the iron-plate (if small enough to lie there at the same time) and place marine glue on the painted flat surfaces of the sides; when melted put on the *ends*, which will form three sides of an open square, then quickly place the other side on the ends, and carefully remove it from the plate to a piece of wood, or paper—the former, provided with a straight edge (like the cutting board) is the best. While the glass remains hot enough to keep the glue soft, press together and critically adjust the glued surfaces, taking especial care that the sides coincide with the angles of the brass square; it is most important to remove from the glue in the joints any extraneous particles of dirt. These preliminaries settled, the glass cold, and the glue hard, the operator will have four sides of a box—like a brickmaker's mould—without top or bottom; this he may now proceed to grind upon the metal plate by a circular motion—constantly turning the box in his hand to prepare it for the bottom: after this is accomplished, it must pass the ordeal of the former test; next the slide or bottom plate of glass must be heated on the iron plate, (it having been previously prepared with the naphtha solution which must also be applied to the ground surface of the box;) and then after melting the marine glue on the upper surface near the edge for the adhesion of the lower edges of the hollow box, this box is to be applied to the slide and the whole suffered to remain on the heated plate of iron long enough for the lower portion of the sides of the box to become sufficiently hot to form a joint with the slide, but without melting the joints previously made; when cold, the upper surface may be ground in the same manner as the bottom, and with like care, and when finished, the vessel will appear like figure 9.

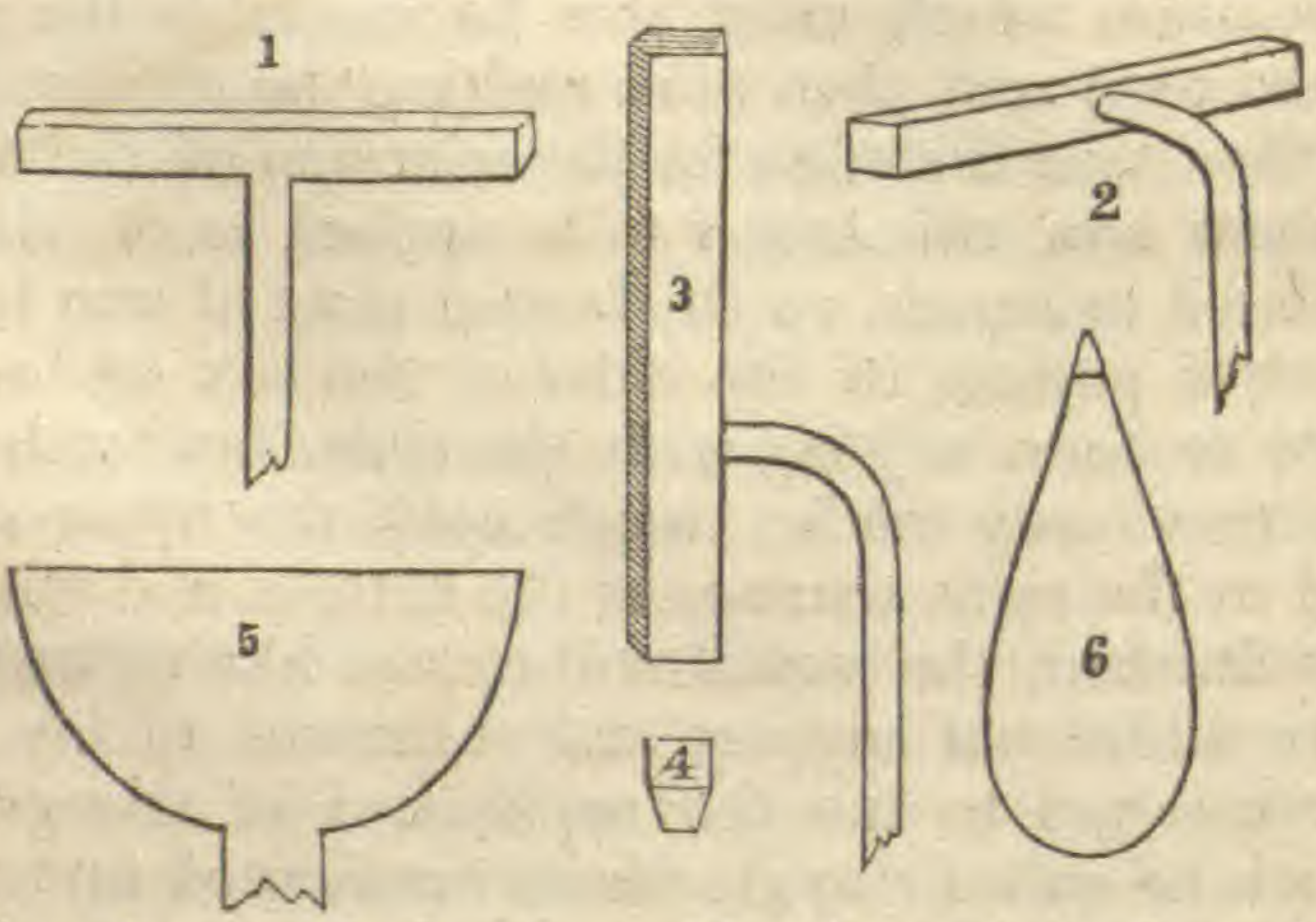
To give additional support and resistance to the joints, Mr. Dennis, suggested to me the application of triangular bars of glass, which he called "angle pieces" cemented into the corners. In my experience of them they fail, for two reasons—one, because they cannot be ground with sufficient accuracy, and the other, that in cementing them the heat is generally so great as to decompose the glue. I have substituted the following plan with more success: I pour melted glue into the corners, and make the angles of the vessel hot enough to keep the glue fluid, while I cause it to run equally from the bottom to the top of the box—this plan has not disappointed my expectation of it in any instance.

10.

I have made several upright vessels some of them of great dimensions (fifteen inches high, six inches wide, and four inches deep) and extremely elegant in their appearance. A preparation of Physalia pelagica (Portuguese man of war), fig. 10, will give an idea of this form of vessel; the original box is eight inches high by two inches wide, five-eighths deep from back to front: *a* represents the front side, *b b*, the end pieces, *c*, a block of polished plate-glass half an inch thick to which the upright box is cemented, *d*, a thinner plate of glass forming with *c* a handsome pedestal and heavy support for the upright vessel.*

The joints of the pedestal, and of the box to the thick upper plate, must be made with Canada balsam or the *chloroform* preparation of marine glue for the sake of transparency; the box must be made, as before directed, with the patent marine glue. When large surfaces of glass are to be cemented together, the iron-plate is insufficient for the purpose and another plan must be had recourse to. I have already remarked that a red-hot soldering iron may be applied to the edges of glass with considerable impunity, and I avail myself of this fact in the manufacture of large upright vessels. Fig. 11 represents the several forms of such irons

11.

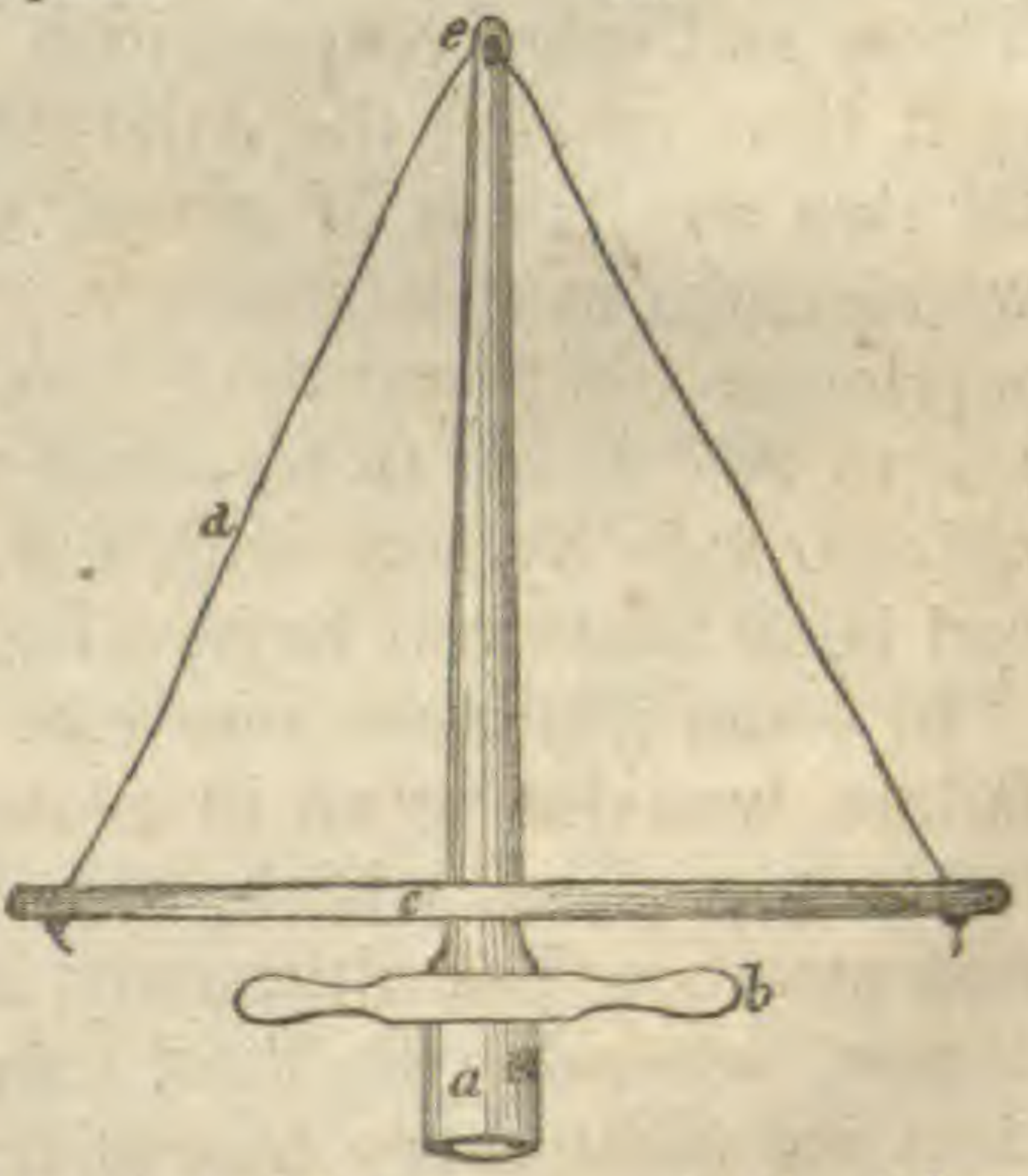


as I have found most desirable. Numbers 1, 2, 3 and 6, are reduced one-half in size; and 5 is more reduced; 1 and 2 are made of iron rod $\frac{5}{16}$ths inch square, welded to a round iron wire which is inserted into a wooden handle; 2 only differs from 1 in having the iron wire bent, as shewn in the figure—they are both eleven inches long, inclusive; 3 is intended to apply the marine glue to the inner angles of the boxes and upright vessels; an end view is shewn at 4. The handle of this last is differently fixed, and its length, including the wooden handle, is fifteen inches; 5 represents a much heavier tool and is designed to retain the heat for a longer time than either of the former. With a pair of such instruments large surfaces of glass can be well and expeditiously soldered.

* The mode of grinding a box of the height here mentioned, does not in any respect differ from that which has been described. Here, the end pieces are considerably elongated and must firstly be made true in the direction of their longer axis —the top and bottom is not to be ground until the hollow box be perfect.

It has sometimes happened in boxes and upright vessels, that in time the ends have been pressed in by the pressure of the atmosphere: to prevent this contingency I soldered on to the sides at the top and bottom, a bar of glass represented by the dotted lines *e*, *f*, fig. 10—they are not shewn at the bottom. These bars should be affixed to the sides before the vessel be made; they will thus, if exact in their length, serve as a guide to the true position of the ends, and being ground with the top and bottom of the vessel when in the form of a hollow box, will give increased surface for the joints to be made at these places respectively. The bars at the top are very useful as a means of fixing the threads by which the preparation is to be suspended; for this especial purpose I make four loops of the silk to be used (China three twist) and place two on each side of the vessel in the exact place they should occupy, and cement them firmly to the vessel by means of the bars—in mounting the preparation, I have merely to tie the threads which pass through it to these loops. In large vessels constructed on the principle lastly described, it is desirable to seal down the top glass with marine glue instead of the black cement. In this case the top glass should be of the exact size of the outside measure of the box and two small holes should be drilled in it at opposite corners—one to let the air out while the vessel is being filled, by means of the other. The process is similar, in all respects, to the description given in relation to preparation jars.

12.



To drill the holes, I use what is called in mechanics a "bob-drill," of which a figure is given. (Fig. 12.) The actual drill consists of a diamond, for a very small hole, a garnet, a crystal of corundum, or a fragment of the corundum, which may be obtained of emery merchants under the name of "emery stone." The operator will mount these drills for himself in a piece of thin tin rolled into a tubular form, with one end adapted to the drill stock.*

The part of the glass to be drilled should be marked either with a scratch diamond or the point of a file. It is only neces-

* The "bob" drill: *a*, the steel stock, $10\frac{1}{2}$ inches long perforated at *e* with a round eye for the transmission of the cord.—*b*, the circular weight either of iron or lead.—*c*, a turned handle $9\frac{1}{4}$ long, perforated with a hole in the center $\frac{5}{8}$ths diameter, through which the drill stock can freely move, and at each end a hole for the cat-gut, *d*, to pass through and be tied in a knot. The drill is inserted at the bottom of the stock below *a*. A thong of dried eel-skin is a far stronger and much more durable cord for such a drill than cat-gut.

sary to use sweet oil, and any of the above named substances (I use all of them) will speedily cut a hole through the glass. Superfine emery in addition to oil may be used, but I believe that it cuts the drill without expediting the process.

For large vessels, I have been in the habit of giving increased strength to all the joints by covering them on the outside with a frame of glass consisting of strips about one-fourth of an inch wide; and, as the top glass is included in this arrangement, the corks plugged into the drilled holes are thereby kept in their place and concealed.

Lastly, I have made such preparations ornamental by water gilding the outer frame or moulding. This last process tries the joints severely; for the gilder's cement which must be applied to the moulding, contracts as it dries, and when dry is unyielding. As it is contrary to all theory that a vessel filled with fluid and hermetically sealed, should endure the ever varying alternations of temperature without change—neither affected by the summer heat nor winter's cold—it is desirable to give my experience in relation to this subject. I have in my possession preparations sealed originally without a bubble of air; one of these, the vessel being 9 inches by 11, half an inch deep, was made in Edinburgh in 1841, and framed as a picture—to this time it has not a bubble of air.

Some dissections of Terebratula australis—mounted seven years ago, are as perfect now as they were when first completed. These and other preparations, have travelled extensively in England, have crossed the Atlantic where they were well tossed about for two weeks out of seven, and they still accompany me in my wanderings in this country. They endured with impunity the capricious temperature of England, and here they have been subject to 90° down to 8°—still without change, while other preparations, side by side with the former, about which as much care had been bestowed have miserably failed—why is this?

In some instances one can readily perceive that the cause of failure was due to an ill made vessel, or to the want of flatness in the top glass, which, although yielding to the cement in the first instance, has ultimately resumed its figure and gaped at one corner, whereby the fluid can escape. But, as this explanation does not meet every case of failure, I have been induced to make experiments with the preserving fluids respectively, subjecting them to the action of high and low temperatures, and watching the results, and these direct experiments agree exactly with the soundness, or the contrary, of all my preparations. I poured some A1 fluid into a glass tube with a bulb, and adapted it to a thermometer scale. I placed this tube and a thermometer into a vessel of water previously regulated to 60°. With ice and salt I gradually lowered the temperature to zero and noted the amount of *contraction* of the A fluid. I then as gradually increased the temperature to 100° and noted the *expansion* of the fluid. I went through a similar course of proceeding with the A2 and the B fluids respectively, always taking 60° as the mean, and 100° and zero as the maximum and minimum temperatures.

From these experiments I deduced the following: in all the fluids the contraction was not equal to the expansion; neither were the results similar with any two fluids; that, the expansion was in direct ratio to the density of the fluid; thus, it is least of all in the A2 and greatest in the B1,148 fluid. The A2 fluid is affected so little by temperature, that the experiments seemed to indicate the probability that this fluid might remain permanent in well secured vessels, and I find that all the sound preparations contain this fluid. The B1,100 fluid is not to be trusted in a higher temperature than 80°; and if subjected to such, B1,148 will expand so decidedly and considerably, as to break the top glass (which is always the thinnest) of the preparation. The experiment with the A2 fluid induced me to think that the expansion and contraction of the glass agreed very *nearly*, or *quite*, it might be, with the fluid; and that the marine glue and black cement fully sympathized. I took, therefore, a sound preparation contained in a large cell, the top cemented with the black cement, and placed it in the water at 60°, and from this point I continued the experiment down to zero, up to 100° as before described, and continued to do this alternately for nearly two hours—to this time it has not undergone any change. I have sometimes been asked, "what provision I made against freezing of the fluid;" no provision is necessary, as it cannot freeze. A fluid of the specific gravity, therefore, of the A2 fluid, may be regarded as the maximum density that can weather the temperature of the atmosphere through all its phases, and the knowledge of this fact makes me fear for the permanency of valuable preparations by my hand, preserved in the denser fluids and now in Europe.

Another fact has resulted, that if a preparation be well and thoroughly preserved in either of the fluids before described, and which may be best adapted to the particular animal, it may be sealed down hermetically without air in a fluid of less specific gravity, and it will be permanent.

The square glass boxes are eminently calculated to give the best effects, as preparations, to a vast number of the invertebrate animals. If a bottle be used, no matter what its shape, the operator has no alternative, but must suspend his specimen from the top, whether it be an animal whose natural habitat is the bottom of the ocean fixed firmly to a solid rock or otherwise, there it must hang mid-way in the fluid like the coffin of Mahomet, 'twixt earth and sky. Surely preparations should be so managed that as far as possible they should tell their own tale, that those persons whose curiosity induces them to scan the contents of a public museum may learn while they look. That a Cephalopod should be seen as if walking on his head; a Tunicated mollusc as if growing from the bottom of the vessel, whilst the beautifully branched Sertularian zoophyte and other animals whose nature it is to cling for support to sub-marine substances should retain, as preparations, all their characteristics in this respect.

In vessels of the form I have described, all such effects can be readily attained, and I have mounted a number of preparations years ago, with special reference to this subject. The naturalist who stuffs birds or beasts, imparts as much of character to his specimens as possible; and the great end that I have always proposed to myself in connection with my glass vessels, is to do as much for those animals that can only be preserved as *wet* preparations, as has hitherto been commonly done with dried specimens, and I believe I have pretty well succeeded.

I have displayed in upright vessels two specimens of Argonauta argo as if walking upon a large piece of branched white coral, the latter being fixed to the bottom of the vessel. Zoophytes attached to shells, or stones, I have displayed as I found them, and so of other animals. * * * *

One of the chief difficulties in the way of examining *wet* preparations, whether in bottles or otherwise, is, that they are literally drowned in light. Now, as every ray of light that is not wanted is in the way, I carefully stop it out. Few preparations have more than *one* really valuable surface—that which in a public museum is placed towards the spectator; by making the opposite surface of the preparation jar black, the light, instead of going through the vessel, is arrested, and all that is superfluous absorbed; the preparation is thrown forward, and there is really in effect more light with which to examine it. The band of black should not be too broad, but nicely apportioned to the requirements of the preparation. Among the few preparations that I mounted in bottles and preparation jars for the museum of the Royal College of Surgeons, I ventured to carry out this idea, and the results fully justify all that I have said or can say. Foremost and most conspicuous amongst those with the black back, is a preparation of the cerebro-spinal axis of man, and the spinal cord of the giraffe—the latter preparation dissected by Prof. Owen, and merely mounted by me—both of which are conspicuously visible at the opposite end of the long gallery in which they are placed. I encountered deeply rooted prejudices, due to an aversion to whatever is new; the introduction of a back ground to a preparation bottle was a novelty, therefore an innovation, and consequently, was not adopted. And yet the preparations referred to stand in the midst of an extensive series of kindred structures, all of which would be amazingly improved by this simple addition.

In my estimation a back ground is of the greatest importance, and it forms an important part of my plan. With the black cement, sufficiently thinned with turpentine to form a paint, I coat that portion of the under surface of every preparation—great and small—that is not immediately beneath the object. Two or three coats of this paint form a beautiful black, which shows through the upper surface of the glass like highly polished marble, for which substance it has frequently been mistaken. Beneath the preparation I place whatever color best contrasts with it, and for this purpose use paper for all colors but black; sometimes white, pale amber, ultra-marine. The under surface of the glass I defend from scratching by pasting paper over its entire surface, and I reserve access to the obverse of the preparation either for the sake of transmitting light for microscopical purposes, or for examining that particular surface, by leaving the paper which lies beneath the object free on three sides, and by pasting it down on the *fourth*, it can be turned back and replaced at pleasure.

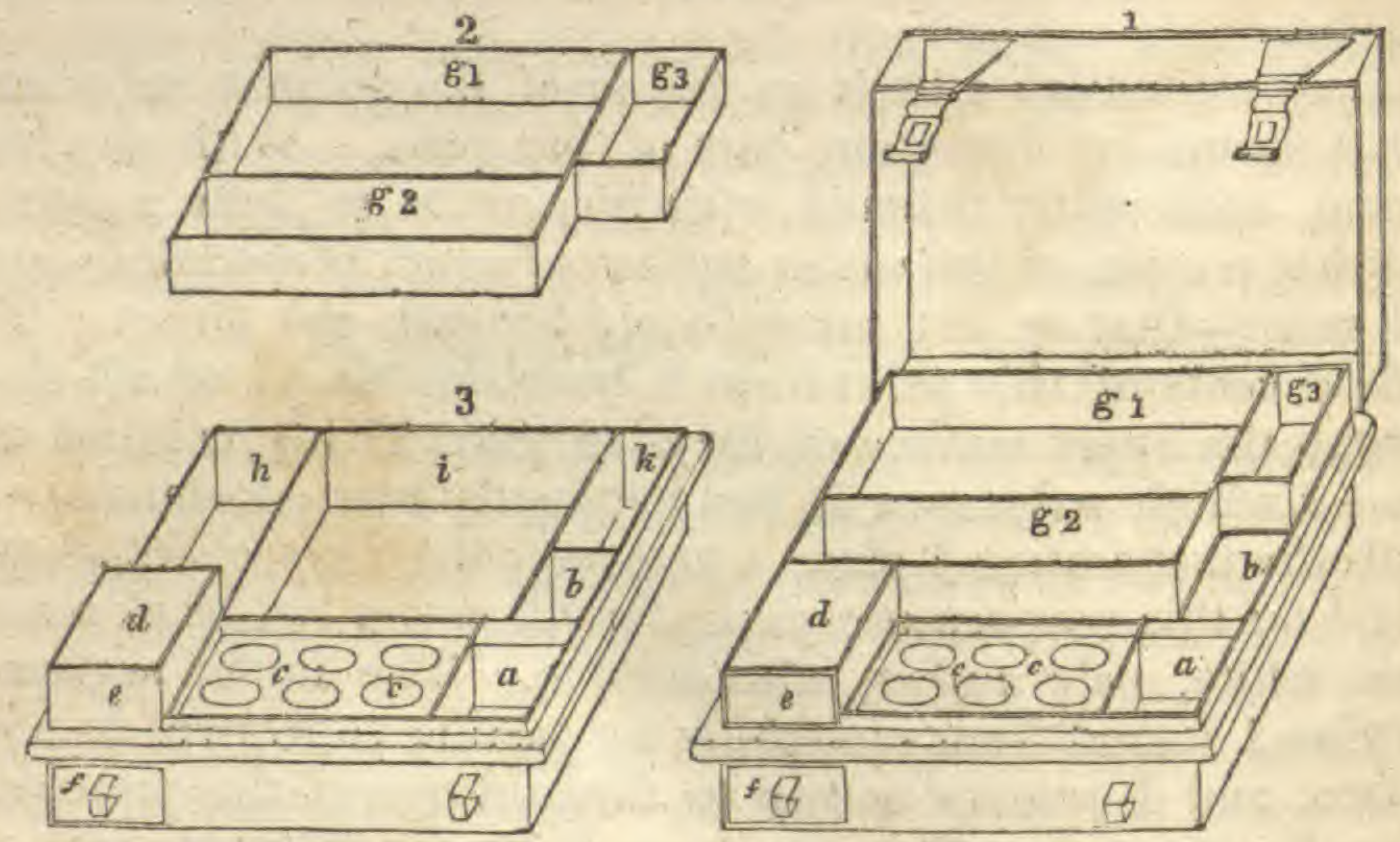
Preparation making is an art demanding much devotion and time to acquire. At present, museums are managed and controlled by men who believe that there is no better plan of proceeding than to put specimens in a bottle with spirit although the liquid soon becomes discolored, and deposits a thick sediment that renders the whole very turbid the instant the bottle is moved; and this is called "a fine preparation," in which opinion those to whom it is submitted generally acquiesce; and this must continue so long as it be the fashion to expend a great sum of money on the *outside* of a museum, and as little as possible within.*

Manipulating Box.—So many little things are required in making preparations, that I determined some years ago to gather them together and contrive a box capable of holding a fair supply of tools and utensils for ordinary work. I drew plans of the several portions of what I considered to be necessary, similar to the details of fig. 13, and I had it made in *tin* as the lightest and strongest material. The actual size of my box, outside measure, is 10 inches by 7, 3½ inches high. No. 1 represents the box when open, No. 2, a movable tray of peculiar form, with three

* Preparations in bottles with stoppers have their use, beyond that of mere exhibition in a museum; for scientific investigation often requires that the specimen be taken from its bottle for particular examination and study.—Eds.

compartments, and No. 3 represents the box when No. 2 is removed from it: the letters from *a* to *f*, indicate the same parts in both figures.

13.



No. 1.—*a*, Compartment to receive a bottle 2 inches square, $3\frac{1}{4}$ high, to the top of the stopper, for preserving fluid.—*b*, Space reserved for the spirit lamp.—*c c*, A shelf of tin perforated with six holes to receive three stoppered, two dram bottles. for liq. potassæ; sulphuric acid; camphene (or turpentine); and three glass jars, $2\frac{5}{8}$ths high, $\frac{7}{8}$ths diameter, made out of stout glass tube without a lip, and fitted with corks for Canada balsam; prepared asphaltum; lampblack and gold size.—*d*, A slab of porcelain, $2\frac{3}{8}$ths square, resting upon a tin frame and carried up so as to be flush with the level of all the bottles, and the tray (2) when in its place. Beneath the slab is *e*, a drawer $2\frac{3}{8}$ths long, $2\frac{1}{4}$ wide and $\frac{3}{4}$ths deep, to hold about three dozen of the smallest slides I use, viz., $2\frac{1}{8}$th by $\frac{3}{4}$ths. Beneath *e* is a deep well which occupies the space from the drawer *e* to *f*, another drawer, which runs the whole length of the box, from front to back; it has the width and depth of *e*.

No. 2.—g^1, This compartment of the tray measures 8 inches long, $2\frac{1}{2}$ *full*, wide, $1\frac{1}{4}$ deep. It contains the iron plate, its brass legs and mahogany stand; a small cutting board kept for thin glass only, measuring 6 inches by $2\frac{3}{8}$ths, $\frac{1}{8}$th thick, furnished with a guide board 5 inches long, $\frac{1}{2}$ inch wide, and $\frac{1}{8}$th thick, and a guage 6 inches long, nearly $\frac{5}{8}$ths wide, and $\frac{1}{8}$th thick. A card-board box, $2\frac{1}{2}$ by $1\frac{3}{4}$ths and $\frac{7}{8}$ths deep, to hold plates of thin glass; the small brass square already described; mahogany square 6 inches by $2\frac{1}{2}$—$\frac{1}{8}$th thick; a number of badger's hair pencils in handles.—g^2, Glazier's diamond; scratch do.; marine glue (cane) brush; knife and engraver's tool for cleaning cells; small glass muller to grind the black cement on the porcelain slab, and sundry glass (dropping and other) tubes.—g^3, Pill box with whiting; white wax for thread; cotton wool; sundries.

No. 3.—*h*, A fixed tray 4 inches by $2\frac{1}{2}$ and $\frac{3}{4}$ths deep, to contain glass for covers to larger cells.—*i*, A well $5\frac{1}{2}$ by 4 inches, $1\frac{1}{2}$ *full* deep, to hold spare slides of the larger size, with, or without cells cemented to them—spare cells, &c.—*k*, A supply of the finest and other varieties of China three twist; pill box containing small pins so necessary in dissecting; pill box containing cells cut in the *thinnest* glass.—Drawer, *f*, contains several small palette knives in ivory handles for mixing the cement on the slab; the blades differ in length from $1\frac{1}{4}$ to $3\frac{1}{8}$th, and from $\frac{1}{8}$th to $\frac{3}{8}$ths at the point; drills for glass and many little things. Below the shelf, *c c*, is a similarly perforated shelf, raised somewhat from the bottom, the design being to grasp the bottles at two points. Should the bottles not be sufficiently high to occupy all the depth allowed for them, they must be raised by a shelf of tin—the intention being that when the box is closed, every thing should be more or less pressed upon and kept in its place. The whole is japanned dead black within and lustrous black without.

ART. XXIII.—*Abstract of Meteorologial Observations, made at Marietta, Ohio,* in Lat. 39° 25′, West Long. 4° 30′ from Washington City, for the year 1851; by S. P. HILDRETH, M.D.

MONTHS.	THERMOMETER. Mean of 3 observations.	Mean of 2 observ'ns.—highest & lowest.	Maximum.	Minimum.	Fair days.	Cloudy days.	Inches of rain and melted snow. In.100	Winds.	BAROMETER. Maximum.	Minimum.	Range.	Mean.
January, -	34·33	35·20	64	–4	25	6	0·50	S., S. W. & W.	30·03	28·80	1·23	29·41
February,	40·70	41·50	66	2	11	17	4·88	S., S. W. & N.	29·95	28·95	1·00	29·45
March, -	46·33	47·20	78	20	21	10	1·44	S., S. E. & N.	29·55	29·00	·55	29·28
April, -	52·33	51·83	80	28	18	12	3·04	N., W., & S. E.	29·75	28·70	1·05	29·23
May, -	61·57	62·47	86	28	19	12	6·00	S. W., N. & E.	29·75	29·12	·63	29·44
June, -	69·00	70·60	88	46	22	8	2·60	S. S. W. & N.	29·70	29·00	·70	29·33
July, -	72·33	72·83	94	52	22	9	2·40	N., S. & W.	29·55	29·20	·35	29·35
August, -	70·27	72·25	87	48	23	8	3·60	N. & S.	29·68	29·25	·43	29·47
September,	66·28	68·50	96	40	25	5	2·38	S., S. E. & N.	29·80	29·15	·65	29·47
October, -	52·33	53·15	81	28	20	11	1·68	S., S. E. & W.	29·60	29·00	·60	29·30
November,	39 52	40·00	71	18	12	18	4·00	N. & W.	29·80	29·90	·90	29·35
December,	28·00	28·00	65	–3	11	20	2·42	W., S. E. & N.	29·80	29·08	·72	29·44
Mean for year,	52·75	–53·62					34·94					

THE mean temperature for the year which has just closed is 52°·75, which is about as usual. The amount of rain has been considerably less than the annual mean for this climate, which is about 42 inches, (but rising occasionally to 53 or 54 inches,) whereas this year it was only 34·94 inches. The years 1834, 1839, and 1845, as well as 1851, were remarkable for the diminished amount of rain. The month of December, as might be expected from the short days and lengthened nights, is our coldest month, and this year has been remarkably severe. A recapitulation of the history of this month for the past twenty-five years, as showing its bearing on the navigation of the Ohio river, may be valuable and interesting in this day of railroad improvements; especially as there is now a road in preparation from Cincinnati to Pittsburgh, along the northern border of the river, pursuing its general direction, a few miles from its waters, which will obviate the serious difficulties now felt from the obstructions to navigation by low water in the summer and autumn, and ice in the winter, viz.:

December, 1825.—Nearly as cold as this year; river closed the 20th of the month; snow a foot deep on the 19th; 6° below zero on the 22d; mean temperature 29°·33.

" 1826.—Ohio closed the 27th to 30th January following; mean temperature of that month 31°·42.

" 1827.—Ohio river open all winter; mean temperature 43°.

December, 1828.—Ohio open all winter; some ice in February; mean temperature 39°·17; for year 55°·22. Rain 49·50 inches.

" 1829.—Ohio closed 27th January, 1830; mean for December 44°·09; mean for the year 55°·22. Rain 39·52 inches.

" 1830.—Mean 35°·74; Ohio full of floating ice the 22d of the month; closed 23d January following, and opened the 20th February; snow fifteen inches in January. Rain for year 37·26.

" 1831.—Mean for month 21°·00; lowest 10°. Rain for the year 53·54 inches. The 8th of this month the Ohio and Muskingum rivers closed, and on the 16th loaded teams crossed with wood, &c.; the ice was from twelve to eighteen inches thick; on the 8th of January following the ice broke up causing great damage to boats, destroying numbers of steamboats, lying at the shore in exposed situations; in February was the great flood of 1832.

" 1832.—Mean 36°; Ohio open all winter. Rain 48·33 inches.

" 1833.—Mean 37°·00; river open all winter. Mean 54°·56.

" 1834.—Mean 36°·66; river closed 6th January, 1835; open again the last of the month; fruit all destroyed this year as in 1851, by frosts in May. Rain for year 34·66 inches.

" 1835.—Mean 31°·00; Ohio closed 28th January following; open the 15th February; thermometer 18° on the 5th. Rain 42·46 inches; mean for that year 50°·65.

" 1836.—Mean 30°·70; navigation obstructed from the 8th December, until the 8th of February. Rain 36·09 inches.

" 1837.—Mean 35°·57; navigation obstructed from 30th January to the 13th of March; February very cold; mean for year 51°·5.

" 1838.—Mean 28°·15; temperature 9 below zero the 31st of the month; the river closed 6th December; opened the 13th January.

" 1839.—Mean 36°·33; Ohio closed the 29th; opened the 15th January; amount of rain 33·32 inches for year.

" 1840.—Mean 30·14; Ohio closed 3d January following and opened the 8th.

" 1841.—Mean 36°·33; no ice this month; open all winter.

" 1842.—Mean 33°·33; much floating ice the 24th November; river closed the 28th; open the 5th December, and the rest of winter.

" 1843.—Mean 35°·00; mean for year 50°·70; open all winter.

" 1844.—Mean 34°·37; rain for year 36·64 in.; open all winter.

" 1845.—Mean 25°·40; at and below zero 2° on four days; Ohio closed the 5th of the month; was open a few days and closed again the 26th. Rain 33·90 inches.

" 1846.—Mean 37°·77; Ohio open all winter.

December, 1847.—Mean 35°·33; rain, December 10th, 10 inches; flood the 15th of the month, covering the bottoms; rain 52·31 inches; the 27th, Ohio full of floating ice, but not closed all winter.

" 1848.—Mean 42°·16; no ice until January; open all winter.

" 1849.—Mean 31°·33; no ice in the Ohio till the last of the month.

" 1850.—Mean 34°·66; rain this month 7 inches; for the year 52·30 inches; rivers open; little ice.

" 1851.—Mean 28°·00; very cold; below zero a number of mornings; Ohio closed the 19th of the month and opened again the 30th.

The mean temperature for the winter months is 36°·56, not far from the mean of our winters.

The mean of the spring months in 1851, is 53°·41. The blossoming of fruit trees was as early as usual, but severe frosts the early part of May destroyed the apple and peach germs through all the southern and eastern portions of Ohio, extending into Virginia and Kentucky. That portion of the state within the influence of the atmosphere of Lake Erie, escaped this calamity; and for the first time, Cincinnati and the towns on the Ohio river, received their apples from New York and the lake shore of Ohio.

The mean of the summer months is 70°·53; the season was temperate, rising only on one day above 90°, on the 26th July reaching 94°. The crops of Indian corn suffered a good deal from drought, from the 22nd August to the 27th September, at a period when this grain needs a full supply of moisture to fill out the kernels; but an abundant rain the last of that month recruited the flagging vegetation. Streams of water and springs were very low in the center of the state, causing a good deal of suffering to cattle and horses, it being difficult in many places to provide a supply for wagoners and stage coaches.

The mean temperature of autumn is 52°·71, which is a little above common years. The hottest weather was felt in September; it rising above 90° on six days—the 12th being at 96°—the greatest heat for many years. The streams continued low all the autumn and the Ohio was not in a fit state for boat navigavion, of produce or flat boats until the 17th November; whereas in most years it rises sufficiently for this purpose in October. A large portion of the produce grown in the vicinity of this river, is taken to markets on the Mississippi by the farmers along its banks, on their own account. As a sample of the vast amount of property afloat on the Ohio, 2000 boats were counted in 24 hours by an ascending steamer, between the mouth of the Scioto and Marietta, a distance of about 200 miles. A large number of these were loaded with coal from Pittsburgh and Wheeling. A flat boat of ordinary size carries 1500 or 2000 barrels of produce.

The year has been fruitful in cereal productions. Excellent crops of wheat, corn, oats and hay, while the potato has escaped destruction by that odious epidemic called "the rot," and thousands of barrels have gone to the markets on the "father of rivers." Fruits of nearly all kinds failed. Grapes fared better than any other, blooming after the frosts had in a measure ceased. Strawberries were abundant, and melons, until the heat and drought of September killed the vines.

Floral Calendar, &c.—Feb. 23d, Garden crocus in bloom.

March 2nd, Robin appears; 16th, Blackbird; 19th, Fruit buds of the pear and peach swollen and ready to open; 23d, Hepatica triloba in blossom; 28th, Peach and Plum in bloom in warm exposures; 31st, Hyacinth, Dodecatheon media, Pyrus japonica.

April 1st, Pear in blossom; 2nd, Peach and cherry; 4th, Cornus Florida, Judas tree and Sanguinaria canadensis; 5th, cut Rhubarb stems two feet long, protected only by an empty flour barrel; 7th, Wood anemone; 10th, Apple in full bloom; 15th, Hard frost, thermometer 28°, peach killed, some pears escaped; 22nd, set out in the garden, Dahlia tubers, Amaryllis, &c.; 24th, Quince in blossom; 25th, Tulips in full bloom, not much injured by the frost; 28th, Harebell and Uvularia.

May 2nd, Hard frost, thermometer 28°; 3d, Chickasaw plum; 5th, Crab apple; 6th, Hard frost, 29°, ice one-sixth inch on water in a bowl,—corn planted the 9th of April not yet up; 9th, Yellow Cypripedia; 12th, Rose-colored Peony; 15th, Purple mulbery, crimson Peony; 19th, Ribes villosa, and Prunus virginiana; 20th, Syringa aromatica; 21st, Purple tree Peony; 26th, Syringa Philadel.; locust blooms very little, hurt by frost; 28th, Garden pea on table.

June 16th, Catalpa tree; 21st, Cucumber raised in open ground protected from frost by boxes, fit for eating.

July 14th, Ribes villosa or blackberry ripe.

Aug. 25th, Brown Beurre pear ripe; 30th, Doyenne pear—these escaped the frost, being protected by buildings near them.

Oct. 24th, First frost to kill Dahlia tops.

Marietta, January 1, 1852.

ART. XXIV.—*Note on Chinese Horology: with suggestions on the form of Clocks, adapted for the Chinese market.* Written for the U. S. Patent Office; by D. J. MACGOWAN, M.D.

A REQUEST made about two years since by the United States Patent Office for information from American citizens resident in China, calculated to be useful to home industry, has not received that attention which it merits, notwithstanding there exists as incentives, on the one hand, the unrenouncable claims of country, and on the other, ample opportunities for complying with that request. Her wide spread territory, the varied productions of her soil, and the high position of China as an agricultural state, lead us to expect that no inconsiderable additions to our own agriculture would result from a careful survey of the various points accessible to foreigners, and it would doubtless be found that many plants indigenous to this soil are capable of being naturalized in one part or another of our continent.

In a manufacturing point of view, although there is much less to repay research, yet there are some branches of industry in this department, the investigation of which could not fail to bring valuable facts to light, and if no more can be done than to point out defects in Chinese labor which our artisans can supply, that alone would prove mutually advantageous to the two great nations on the opposite shores of the Pacific. *Clock-making*, which forms the subject of this note, is a case in point; and it is believed that with a modification to be suggested, American clocks can be made an article of extensive import into China. For a long period the importation of clocks and watches, chiefly the former, into this country from the continent of Europe, was little short of half a million of dollars annually. This trade has nearly ceased, partly owing, no doubt, to the rapid impoverishment of the country by the opium traffic, and partly to the fact that native manufacturers are able to compete with foreigners. Yet clocks are not often met with in China; they are chiefly confined to the public offices, where it is common to find half a dozen, all in a row. The number annually manufactured cannot be large, for in the richest cities of China, clock-makers are not numerous. At Nankin there are forty shops, at Suchau thirty, Hangchau seventeen, and at Ningpo seven. The average number of men employed in each being less than four—who are mostly occupied in *repairing* watches and clocks. The cheapest clock they make costs $7. Some are worth as much as $100, the most common price being about $25 each. A manufacturer estimates the number of clocks made at the above places at one thousand per annum, and probably five hundred more would more than cover the whole annual manufacture of the empire. A few watches are made, with the exception of chains and springs, which are imported. The oil used by Chinese workmen to abate friction appears to be particularly adapted for that purpose, though expensive; it is obtained from the flowers of the *Olea fragrans.*

Before describing the kind of clock which seems adapted for this market, a brief glance at the history of the horological art in China may not be inappropriate. It had its rise as in the western side of Asia, in the *Clepsydra.*

Assuming, what is in the highest degree probable, the authenticity and accuracy of the Shúking, we find that forty-five centuries* ago, the Chinese had occupied themselves with the construction of astronomical instruments somewhat similar to the quadrant and armillary sphere, and the observations they made with them, even at that remote period, are remarkable for their accuracy, enabling them to form a useful calendar;—the present cycle of sixty was adopted at that time by Hwangti, 2697–2597 B. C. To this emperor is attributed the invention of the clepsydra. The instrument at that period was probably very rude, and not used as a time-piece, but for astronomical purposes, in the same manner as employed by Tycho Brahe for measuring the motion of stars, and subsequently by Dudely in making maritime observations. It was committed to the care of an officer of rank, styled Clepsydra Adjustor.

The greatest philosopher in Chinese history anterior to Confucius was Duke Chau, the alleged inventor of the compass; he appears also to have been the first to employ the clepsydra as a time-piece. He divided the floating index into one hundred equal parts or "*Kih.*" In winter, forty kih were allotted to the day and sixty to the night, and in summer this was reversed. Spring and autumn were equally divided. This instrument was provided with forty-eight indices—two for each of the twenty-four terms of the year. They were consequently changed semi-monthly, one index being employed for the day, and another for the night. Two were employed every day probably to remedy in a measure the obvious defect of all clepsydras—of varying in the speed of their rise or fall, according to the ever varying quantity of water in the vessel; which might be done by having the indices differently divided. To keep the water from freezing in winter, the instrument was connected with a furnace and surrounded by heated water. Chau flourished eleven centuries

* Chronology.—Although doubts may exist respecting the absolute accuracy of Chinese chronology, it must nevertheless be admitted, that it is so far correct as to render arguments founded on the commonly received chronology altogether untenable, and it is matter of regret, therefore, that the latter has been followed in their Chinese publications by all Romish and Protestant missionaries. I cannot too earnestly urge the adoption of Hale's chronology, and that speedily, lest in the mean time some Chinese Celsus or Porphyry should arise and bring objections against our faith not easily answered, to the satisfaction of their countrymen.

before our era. The forms of the apparatus have been various, but they generally consisted of an upper and a lower vessel, always of copper, the former having an aperture in the bottom, through which water percolated into the latter, where floated an index, the gradual rise of which indicated successive periods of time. In some, this was reversed, the float being made to mark time by its fall. A portable one was occasionally employed in ancient times on horseback, in military tactics.

Instruments constructed on the same principles with the above were in use among the Chaldeans and Egyptians at an early period; that of Clesbius of Alexandria being an improvement over those of more ancient times. The invention of Western Asia, was doubtless wholly independent of that of the East, both being the result of similar wants. Clepsydras were subsequently formed of a succession of vessels communicating by tubes passing through birds, dragons, &c., which were rendered still more ornamental, by the indices being held in the hands of genii.

The earliest application of motion, to the clepsydra, appears to have been in the reign of Shuen-ti (126—145 A. D.) by Tsiang-hung, who constructed a sort of orrery, representing the apparent motion of the heavenly bodies around the earth, which was kept in motion by dropping water. There is reference also to an in-instrument of this description in the third century.

In the sixth century an instrument was in use which indicated the course of time by the weight of water as it gradually came from the beak of a bird and was received on a vessel in a balance, every pound representing a *kih*. About this time, mercury began to be employed instead of water, which rendered the aid of heat in winter unnecessary. Changes were made also in the relative number of *kih* for day and night, so as to vary with the seasons.

As in Europe, monks of the Roman church devoted considerable attention to mechanical inventions, especially in the construction of instruments for measuring time, for the regulation of their worship, and vigils; in like manner also, Budhist monks in their silent retreats, but at an earlier period, similarly occupied themselves and for the same purpose. Several instruments designed as time-pieces, the inventions of priests, are mentioned in Chinese history. They present nothing novel, however, with the exception of one, which was nothing more than a perforated copper vessel placed in a tube of water, which gradually filled and sunk every hour, requiring of course frequent attention.

Although their knowledge of hydrodynamics has ever been very limited, the Chinese appear to have been the first to devise that form of clepsydra to which the term water-clock is alone properly applied, that is to say, composed of apparatus which rendered watching unnecessary by striking the hours. Until the commencement of the eighth century, the persons employed to watch the clepsydra in palaces and public places, struck bells or drums every *kih*, but at this period a clock was constructed, consisting of four vessels, with machinery which caused a drum to be struck by day, and a bell by night, to indicate the hours and watches. No description of the works of this interesting invention can be found. It is possible, however, that the Saracens may have anticipated them in this invention of water-clocks.

In the history of the Tong dynasty (620—907) it is stated that in the Fahlin country, (which in this instance doubtless means Persia, though the best living authority amongst the Chinese makes it Judea,) there is a clepsydra on a terrace near the palace, formed of a balance which contained twelve metal or gold balls, one of which fell every hour on a bell, and thus struck the hours correctly. It is not improbable that this instrument is identical with the celebrated one which the king of Persia sent in 807 to Charlemagne.

In 980 an astronomer named Tsiang, made an improvement on all former instruments, and which, considering the period, was a remarkable specimen of art. The machine, which was in a sort of miniature terrace, was ten feet high, divided into three stories, the works being in the middle. Twelve images of men, one for every hour, appeared in turn before an opening in the terrace. Another set of automata struck the twelve hours and the *kih* or eighths of such hours. These figures occupied the lower story. The upper was devoted to astronomy, where there was an orrery in motion, which it is obvious must have rendered complex machinery necessary. We are only told that it had oblique, perpendicular, and horizontal wheels, and that it was kept in motion by falling water.

As the Saracens had reached China by sea, at the close of the eighth century, and by land at an earlier period, some assistance may have been derived from them in the construction of this instrument, but I am disposed to consider it wholly Chinese. Beckman, after much learned research, ascribes the invention of clocks to the Saracens, and the first appearance of these instruments in Europe to the eleventh century.

Mention may here be made of other instruments of the same description, also constructed about this period. One, which like the last, united an orrery and clepsydra, was formed in one part like a water lily, whilst in another were images of a dragon, a tiger, a bird and a tortoise, which struck the *kih* on a drum, and a dozen gods, which struck the hours on a bell; with various other motions, besides a representation of the revolution of the heavenly bodies. The machinery of another of these was moved by an undershot water-wheel, its axis was even with the ground, and consequently the frame containing it was partly below the surface. The motions of the sun and moon, stars and planets, were made to revolve around a figure of the earth, represented as a plain, from east to west. Images of men struck the hour, and its parts. In this, however, as in all the aforenamed instruments, the sounds struck were doubtless always the same, as the Chinese do not count the hours. Another machine was constructed which also represented the motions of the heavenly bodies. It was a huge hollow globe, containing lights, and perforated on its surface, so as to afford in the dark a good representation of the heavens. This also was set in motion by falling water. Subsequent to this, various machines are mentioned, but the brief notices given afford nothing of interest until we approach the close of the Yuen dynasty, the middle of the fourteenth century. Shungtsing, the last of the race of the great Genghis Khian, depicted in history as an effeminate prince and as having the physiognomy of a monkey, was evidently a man of great mechanical skill; and to the last, when his dominions were slipping from him, and confusion reigned everywhere, he amused himself by making models of vessels, automata, and time-pieces. His chief work was a machine contained in a box, seven feet high, and half that in width, on the top of which were three small temples. The middle of these temples had fairies holding horary characters, one of which made her appearance every hour. Time was struck by a couple of gods, and it is said they kept it very accurately. In the side temples were representations of the sun and moon respectively, and from these places genii issued, crossing a bridge to the middle temple, and after ascertaining, as it were, the time of day from the fairies, returning again to their quarters. The motions in this case were, it is thought, effected by springs. An instrument somewhat similar is described as an ornament, in the palace of the capital of Corea; it was a clepsydra with springs, representing the motions of the celestial orbs, and having automata to strike the hour. Since the introduction of European clocks, clepsydras have fallen into disuse. The only one perhaps in the empire, is that in the watch tower in the city of Canton; it is of the simplest form, having no movements of any kind, but it is said to keep accurate time. The Chinese automata, so much admired, are, in their internal structure, imitations of foreign articles, as their name implies.

In *dialling*, the Chinese have never accomplished anything, being deficient in the requisite knowledge of astronomy and mathematics. It is true, the projection of the shadow of the gnomon was carefully observed at the earliest historic period, but this was for astronomical purposes only.* Proper sun dials were

* It was by a gnomon that the ancient Chinese endeavored to ascertain the centre of the earth. A measurement of the length of the solstitial shadow, made at Loyang, on the Yellow River, 1200 B. C., was found by Laplace (quoted by Humboldt, in Cosmos, vol. ii, p. 115) to accord perfectly with the theory of the obliquity of the ecliptic, which was only established at the close of the last century.

unquestionably derived from the West. But they were *not* introduced, as Sir J. F. Davis supposes, by the Jesuits; the Chinese are probably indebted to the Mahomedans for this instrument, although we find an astronomer endeavoring to rectify the clepsydra by means of the sun's shadow projected by a gnomon, about a century earlier than the Hegira. There is a sun dial in the imperial observatory at Pekin above four feet in diameter. Smaller ones are sometimes met with in public offices. These were all made under the direction of missionaries of the Roman church, or their pupils. From remote antiquity, a family named Wang, residing in Hiuning, N. lat. 29° 53′, long. E. Greenwich 118° 17′, in the province of Ganhwui, has had the exclusive manufacture of pocket compasses, with which sundials are often connected. In most of these, a thread attached to the lid of the instrument serves as a gnomon, without any adaptation for different latitudes, although they are in use in every part of the empire. Another form, rather less rude, is employed by clockmakers for adjusting their time pieces; it is marked with notches, one for each month of the year, to give the gnomon a different angle every month. The Japanese instrument exceeds that of China in every respect.

Time is not unfrequently kept by igniting incense sticks, the combustion of which proceeds so slowly and regularly as to answer for temporary use tolerably well.

Hour glasses are scarcely known in China, and only mentioned in dictionaries as instruments employed in western countries to measure time.

A native writer on antiquities says, "the western priest Límátau (M. Ricci,) made a clock which rendered and struck time a whole year without error." The clock brought out by Ricci, if not the first seen in China, is the earliest of which mention is made in Chinese history. They subsequently became an article of import, and as already mentioned, this branch of trade was at one time of considerable value. Clocks and watches of very antique appearance are often met with, specimens of the original models scarcely to be found in any other country; some of the latter by their clumsy figure remind one of their ancient name "Nuremberg eggs," but their workmanship must have been superior to that of most modern ones, or they would not be found in operation at this late day.

The Chinese must have commenced clock making at an early period, as none now engaged in the trade, can tell when or where it originated; nor can it be easily ascertained whether their imitative powers alone enabled them to engage in such an undertaking, or whether they are indebted to the Jesuits for what skill they possess. It is certain that the disciples of Loyala had for a long time, and until quite recently in their corps at Pekin, some who were machinists and watchmakers. One of these *horolo-*

gistes complains in *Lès Lettres Ediçiante et Curieuse*, that his time was so occupied with the watches of the grandees, that he had never been able to study the language. Doubtless the fashion which Chinese gentlemen have of carrying a couple of watches which they are anxious should always harmonize, gave the fathers constant employment. A retired statesman of this province has published a very good account of clocks and watches, accompanied with drawings representing their internal structure in a manner sufficiently intelligible.

The Chinese divide the day into twelve parts, which are not numbered, but designated by characters, termed, rather inaptly, horary. These terms were originally employed in forming the nomenclature of the sexegenary cycle, (2657 B. C.) which is still in use. It was not until a much later period, that the duodecimal division of the civil day came into use, when terms to express them were borrowed from the ancient calendar. The same characters are also applied to the months. The first in the list (meaning Son,) is employed at the commencement of every cycle, and to the first of every period of twelve years, and also to the commencement of the civil day—at 11 P. M.—comprising the period between this and 1 A. M. The month which is designated by this term is not the first of the Chinese year, but singularly enough coincides with January. Each of the twelve hours are divided into eight *kih*, corresponding to quarter hours. This diurnal division of time does not appear to have been in use in the time of Confucius, as mention is made in the spring and autumn annals of the ten hours of the day, which accords with the decimal divisions so long employed in clepsydras, the indices of which were uniformly divided into one hundred parts. A commentator of the third century of our era, in explaining the passage relating to the ten hours, adds a couple more, but even at that time, the present horary characters were not employed.

The diagram, Plate I, represents the form I would recommend as suitable for the dial plates of clocks manufactured for this market. The small characters on the outer circle are numerals, exactly corresponding to the Roman figures on western clocks. The inner circle contains the twelve horary characters, and within these are the signs for noon, evening, midnight, and dawn. In the horary circle the large single characters represent whole hours, and the small double ones half hours, equal to a whole European hour.

Let the minute hand extend to the inner part of the outer circle, and make *twelve* revolutions in a diurnal period. The hour hand should reach to the inner edge of the horary characters, and make *one* revolution in the same period of time. Let the pendulum vibrate seconds as now, and the minute hand at the expiration of sixty seconds make half a revolution. It should strike from 1 to 12 A. M. and P. M., and correspond in this respect to European clocks. It will be understood then, that at our *even* hours, the short hand will point to a large horary character,——the middle of a Chinese hour,—and the long hand will be *directly upward;* and at our *odd* hours the former will be opposite the small characters, which point the commencement of their hour and the latter will point *directly downwards*, or at the 12 P. M. of our clocks. Or to repeat the same in another manner,—at 1 o'clock P. M., our reckoning, the hour hand will be half way between the large character at the top and the next one to the right, and the minute hand having made half a revolution, will point perpendicularly downwards and the clock strike one. At the expiration of another of our hours, a whole Chinese hour will have expired when the former hand will have reached the first large character to the right and the latter be directed to the zenith, the clock striking two.

After this, perhaps unnecessarily minute description of what is wanted in the machinery, a few words remain to be added, respecting the instrument as a whole. In the first place, it should be *well* made. A few worthless ones would damage the business irreparably. They should be of brass, and placed in frames of wood, which will not be easily affected by atmospheric changes. Common pine wood veneered with mahogany, have answered well. Spring clocks will not succeed. Some of this description lately sent from New York cannot be kept in repair, whilst a quantity of clocks moved by weights manufactured chiefly in Connecticut, imported into China above seven years ago, have proved good time pieces and give no trouble.

With regard to the external appearance on which so much depends, I would advise, that in every case, there be as much of the works exposed as possible, through an opening in the dial plate. A Chinaman not only wishes to see what he is buying, but what is going on in his instrument when bought, and as his countrymen have the merit of being extreme utilitarians, mirrors in the lower part of the door will be generally preferred to any other ornament. Some, however, should be ornamented at this point for the sake of variety, and perhaps nothing would please more than such a grouping of objects by the artist, as would represent a river, bringing into view a steamboat and a sloop, and on the banks a railroad, locomotive and cars, a steepled church or many storied hotel in the distance, and a stage coach also. Or another interesting device would be afforded by a representation of the solar system, but this would need to be accompanied with several Chinese characters.

It is of primary importance that a particular description of the manner of using the clock, the mode of putting it up, setting it off, winding, regulating, &c., should be given. These directions, which should be more minute than if designed for English readers, can be translated and printed very easily in this country. But there would be no difficulty in printing the directions by means of wooden blocks in the manufactory at home. In copying the characters for the astronomical characters or descriptions of any kind which may be needed by individuals trying the experiment of clock making for China, I shall furnish most cheerfully for the privilege of increasing the utility of the instrument by introducing with them a few passages of sacred scripture.

It may be asked, why if such a clock be needed by the Chinese, they have never constructed one for themselves? It is certainly marvellous that they should manufacture clocks, including dial plates, and always employ Roman figures, and follow the reckoning of foreigners, which so few of them are able to comprehend, and which by all are considered mysterious and outlandish. It is only to be accounted for on the ground of their limited inventive abilities and high powers of imitation. That a time-piece of this description would be in demand in China, I am perfectly satisfied, from inquiries made of natives in various quarters. Chinese merchants say that they should be retailed at about \$5 or \$6 each. If I recollect rightly they can be made in Connecticut at \$2.50, which would afford sufficient profit both for the mechanic and the merchant.

Ningpo, July 4th, 1851.

Art. XXV.—*On Ventilation by the Parlor Fire;* by William Hosking, Esq., Professor of Architecture and of Engineering Constructions at King's College, London.*

The term ventilation does not strictly imply what we intend by its use in reference to buildings used as dwelling-houses, or otherwise for the occupation of breathing creatures. To ventilate is defined "to fan with wind;" but one of the main objects for which houses and other enclosed buildings are made, is shelter from the wind. Inasmuch, however, as the wind is but air in motion, and we can only live in air, air may not be shut out of our houses, though, for comfort's sake, we refuse to admit it in the active state of wind. But in doing this—in shutting out the wind—we are apt to put ourselves upon a short allowance of air, and to eke out the short allowance by using the same air over and over again.

There is a broad line of distinction, indeed, to be drawn between in-door and out-door ventilation; for although the principles upon which nature proceeds are the same, the operation is

* Read at the Royal Institution of Great Britain.

influenced by the circumstances under which the process may be carried on. Whether it be on the hill-side, open to the winds of heaven, or in a close room, from which all draught of air is excluded, the expired breath, as it leaves the nostrils heated by the fire in the lungs, rises, or seeks to rise, above their level, and may not be again inhaled. Out of doors the cooler or less heated air of the lower level presents itself for respiration unaffected by the spent exhaled air, but in a close apartment, the whole body of included air must soon be affected by whatever process any portion of it may have undergone. The process by which nature carries off spent air, purifies, and returns it uncontaminated, is thus checked by the circumstances under which we place ourselves within doors. All our devices for shelter from the weather, and for domestic conveniences and comfort, tend to prevent the process provided by nature from taking effect according to the intention in that respect of the Creator. We not only confine ourselves, indeed, and pen up air in low and close rooms, but we introduce fire by which to warm the enclosed air; wanting light within our dwellings when daylight fails, we introduce another sharer in the pent-up air of our rooms, being fire indeed in another form, but generally under such circumstances, that it not only abstracts from the quantity, but injures the quality of what may remain. But fire, whether in the animal system, in the grate, or in the lamp, cannot long endure the imagined limitation of air. There must be access of air—of vital air—by some channel or other, or the fire will go out.

An open fire in the grate must however have a vent for some of its results, or it will be so disagreeable a companion that its presence could not be endured, even as long as the most limited quantity of air would last; and the fire will compel the descent of air by the vent commonly supplied under the name of a flue —a chimney flue—to render its presence tolerable in a closed room, if a supply be not otherwise attainable. But as the outer air at the higher level of the top of a chimney, because of the rarity of the air in and above the flue, responds to the demand of the fire less easily than the lower air, or that at and about the level of the fire; and the lower air, or air at the lower levels, forces its way in, therefore, by any opening it can find or make —through the joints of the flooring-boards, and under the skirtings—the supply passing first up or down the hollow lathed and plastered partitions, sometimes even up from the drains; and through the joints under and about the doors and windows. If these channels do not exist, as they may not when the joiners' work and the plastering are good, or when the open joints referred to are stopped up by any means, the fire smokes, and every known means of curing the chimney failing, means are sought of obtaining heat without the offending fire. Ventilation is not thought of yet.

The open fire may be made to give place to the close stove or to hot-air pipes, to hot-water pipes, or to steam-pipes—which make hot the air about them in a close room without causing draughts. But the warmth obtained in pipes is costly under any circumstances. Air does not take up heat freely, unless it be driven and made to pass freely over the heated surface; and there being little or no consumption of air, and consequently little or no draught, in connection with heated bodies, such as close stoves and hot pipes, the heat from them is not freely diffused, and is not wholesome. There is with all the expense no ventilation.

Stoves and hot pipes are, moreover, exceedingly dangerous inmates in respect of fire. Such things are the most frequent causes, directly or indirectly, of fires in buildings. Placed upon, or laid among or about the timbers and other wood-work of hollow floors, and hollow partitions, and in houses with wooden stairs, more conflagrations are occasioned by hot pipes and stoves, than by anything else, and perhaps more than all other things together.

Open stoves with in-draught of air warmed by being drawn quickly (when it is drawn quickly) over heated surfaces may be made part of a system of safe and wholesome in-door ventilation; but to be perfect there must be also out-draught with *power* to compel the exit of spent or otherwise unwholesome air. But the arrangements for and connected with such stoves are special, and therefore costly, unless the buildings in which they may be employed have been adapted in building to receive them. An in-draught stove may, however, be applied with great advantage as it regards the general warmth and ventilation, in the lowest story of any house, if there be compelled out-draught at the highest level to which it will naturally direct itself if it be not retained, so that the in-draughted air, tempered as it enters, may be drawn out as it becomes spent, or otherwise contaminated.

But this must be considered in all endeavors to effect in-door ventilation, or the endeavor will fail. *The air must be acted upon, and not be left, or be expected, to act of itself, and to pass in or out as may be desired, merely because ways of ingress and egress are made for it.* Make a fire in a room, or apply an air-pump to the room, and the outer air will respond to the power exerted by either by any course that may be open to it, and supply the place of that which may be consumed or ejected; but open a window in an otherwise close room and no air will enter; no air can enter, indeed, unless force be applied as with a bellows, whereby as much may be driven out as is driven in, with the effect only of diluting not of purifying. Even at that short season of the year in which windows may be freely opened, unless windows are so placed as to admit of the process of out-door ventilation being carried on through them by a thorough draught from low levels to high levels, open windows are not sufficient to effect thorough in-door ventilation. There must for this purpose be in every room a way by which a draught can be obtained, and this draught must take effect upon the most impure air of the room, which is that of the highest level. The chimney opening may supply a way at a low level, and a draught may be established between it and the window, but the air removed from the room by such a draught is not necessarily the spent or foul air. But make an opening into the chimney flue near the highest level in the room, that is to say, as near as may be to the ceiling, and if a draught be established between the window and the flue by this opening, the ventilation is complete; that is to say again, if there be draught enough in the chimney flue from any cause to induce an up-current through it, or if there be motion of the external air to drive the air in at the window and force an up-current through the flue.

Windows may not be put open in the long enduring colder season, however, and for the same reason in-draughts of the outer air by any other channel are offensive and injurious. To open a door for the sake of air is but a modification of opening a window, and, if the door be an internal one, with the effect of admitting already enclosed, and, probably, contaminated air. Means of efficient in-door ventilation must therefore be independent of windows and doors; and the means should be such as will lead to a result at once wholesome and agreeable.

Many plans have been suggested, and some have been carried into effect, of warming air, and then forcing it into or drawing it through buildings, and, in the process of doing so, removing the foul or spent air from the apartments to which it may be applied. Some of these plans are more and some are less available to wholesome and agreeable in-door ventilation, but even the best are rather adapted to large apartments, such as those of hospitals, churches, theatres, and assembly-rooms, than to private dwelling-houses in which the rooms are small and labor and cost are to be economized.

Plans have been proposed, too, for the economical ventilation of dwelling-houses: but they seem to be all in a greater or less degree imperfect. Ways of access are provided in some cases for the outer air directly to the fire in every apartment, to feed the fire, and indirectly to ventilate the room; way of egress in addition to the chimney opening and the chimney flue being sometimes provided for the spent air of a room; sometimes, indeed, as before indicated, by an opening into the chimney flue near the ceiling. A direct in-draught of cold air is not agreeable, and it may be pernicious, but if the outer air become warm in its way to the inmates of the room, the objection to its directness ceases. If however the warmth is imparted to it with foulness, the process does not fulfill the condition as to wholesomeness, and this is the case, when the outer air is admitted at or near to the ceiling to take up warmth from the spent and heated atmosphere of the higher levels. Having undergone this process, it is not the fresh air that comes warmed to its inmates, but a mixture of fresh and foul air that cannot be agreeable to any inmate conscious of the nature of the compound.

The endeavor on the present occasion was to show how the familiar fire of an apartment may be made to fulfill all the conditions necessary to obtain in-door ventilation, to the extent at least of the apartment in which the fire may be maintained, and while it is maintained.

A fire in an ordinary grate establishes a draught in the flue over it with power according to its own intensity, and it acts with the same effect, at least, upon the air within its reach, for the means which enable it to establish and keep up the draught in the flue. The fire necessarily heats the grate in which it is kept up, and the materials of which grates are composed being necessarily incombustible, and being also ready recipients and conductors of heat, they will impart heat to whatever they may be brought into contact with them.

It is supposed that the case containing the body of the grate is set on an iron or stone hearth in the chimney recess, free of the sides and back except as to the joints in front. Let all communication between the chamber so formed about the back and sides of the grate and the chimney flue be shut off by an iron plate, open only for the register flap or valve over the fire itself. External air is to be admitted to the closed chambers thus obtained about the grate by a tube or channel leading through the nearest and most convenient outer wall of the building and between the joists of the floor of the room, to and under the outer hearth or slab before the fire, and so to and under the back hearth in which sufficient holes may be made to allow the air entering by the tube or channel to rise into the chamber about the fire-box or grate. Openings taking any form that may be agreeable are to be made through the cheeks of the grate into the air-chamber at the level of the hearth. In this manner will be provided a free inlet for the outer air to the fire-place and to the fire, and of the facility so provided the fire will readily avail itself to the abolition of all illicit draughts. But the air in passing through the air-chamber in its way to the fire which draws it, is drawn over the heated surfaces of the grate and it thus becomes warmed, and in that condition it reaches the apartment.

An upright metal plate set up behind the openings through cheeks of the grate, but clear of them, will bend the current of warmed air in its passage through the inlet holes, and thus compel the fire to allow what is not necessary to it to pass into the room; and if the opening over the fire to the flue be reduced to the real want of the fire, the consumption of air by the fire will not be so great as may be supposed, and there will remain a supply of tempered air waiting only an inducement to enter for the use of the inmates of the apartment. An opening directly from the room into the flue upon which the fire is acting with a draught more or less strong, at a high level in the room, will afford this inducement; it will allow the draught in the flue to act upon the heated and spent air under the ceiling, and draw it off; and in doing so will induce a flow of the fresh and tempered air from about the body of the grate into the room.

The mode thus indicated of increasing the effect of the familiar fire, and making it subservient to the important function of free and wholesome ventilation, is not to be taken as a mere suggestion, and now for the first time made. It has been in effective operation for six of seven years, and is found to answer well with the simple appliances referred to. But it is the mode and the principle of action that it is desired to recommend, and not the appliancess, since persons more skilled in mechanical contrivances than the author professes to be, may probably be able to devise others better adapted to the purpose.*

The mode referred to of warming and ventilating apartments by their own fires is most easy of application, and in houses of all kinds, great and small, old and new, and as the warmth derived from the fire in any case, comes directly by the in-draughted air, as well as by radiation of heat into the air of the apartment, fuel is economized. If the register flap be made to open and shut, by any means which give easy command over it, so that it may be opened more or less according to the occasion, and this be attended to, the economy will be assured; for it is quite unnecessary to leave the same space open over the fire after the steam and smoke arising from fresh fuel have been thrown off, as may be necessary immediately after coaling. The opening by the register valve into the flue may be reduced when the smoke has been thrown off, so as to check the draught of air through the fire, and greatly to increase the draught by the upper opening into the flue, to the advantage of the ventilation and to the saving of fuel, while the heat from the incandescent fuel will be thereby rather increased than diminished.

Moreover the system being applicable in the cottage of the laborer, as fully and easily as in the better appointed dwellings of those who need not economize so closely as laboring people are obliged to economize, the warmed air about the grate in a lower room may be conveyed directly from the air-chamber about the

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* The appliances used by Mr. Hosking will be found more fully described in his "Healthy Homes," published by Mr. Murray.

grate by a metal or pot pipe, up the chimney flue, and be delivered in any upper room next to the same flue and requiring warmth and ventilation, the process of ventilation applied to the lower room being applicable to the upper room also.

The indicated means by which winter ventilation is obtained are not of course equally efficient in summer, for the draught of the fire is wanting; but the inlet at the lower level for fresh air, and the outlet for the spent air at the upper level continuing always open, the heat which the flue will in most cases retain through the summer aided by that of the sun's rays upon the chimney top, secures a certain amount of up-draught, which is not without its effect upon the in-draught by the lower inlet even when windows and doors are shut.

While it is obvious that the air drawn into any house for the purpose of in-door ventilation need not be other than that which would enter by the windows of the same house, it may be necessary to enter into an inquiry as to the condition of the air heretofore spoken of as fresh and pure. "Fresh" and "pure" applied to air must be taken to mean the freshest and purest immediately obtainable, and that will be the same whether it be drawn in through a grated hole in a wall, or by a glazed opening closed by it in the same wall. But it is a fair subject for inquiry, whether,—speaking in London to Londoners,—the air about our houses in London is as pure,—or as free from impurity—as it might be.

The out-door ventilation of large towns may be taken to be more complete above the tops of the houses and of their chimneys than it is, or, perhaps, can be among and about the houses. The processes of nature are there not only unchecked, but are in fact aided by the heat thrown up by the chimneys into the upper air, and impurities which can be passed off by chimney flues, will be more certainly and more effectually removed and changed by nature's chemistry than if they are kept down to fester under foot and to exhale in our streets and about our doors and windows.

At this time every endeavor is made to provide for removing from our dwellings all excrementitious matter, and all soluble refuse, by drains into sewers, and so by the sewers to some outfall for discharge. The drain necessarily falls towards the sewer, and the sewer again to its outfall, and the sullage or soil drainage being rendered liquid thus passes in the usual course. But the usages and the necessities of civilized life cause a large proportion of the liquid refuse from dwelling-houses to pass off in a heated state, or to be followed by hot water arising from culinary processes, and from washing in all its varieties. The heat so entering the drains causes the evolution of fetid and noxious gases from the matters which go with, or have gone before, the hot water; and with these gases house-drains almost always, and sewers commonly, stand charged. They are light fluids and do not go down with the heavy liquid matters from which they have been evolved, but they seek to rise, and constantly do rise in almost every house through imperfections or derangements of the flaps and traps which are intended to keep them down, but which only, when they do act, compel some of the foul air to enter the sewers, and there to seek outlet to the upper air which they find by the gulley gratings in the streets.

It can hardly be said perhaps that *too much* attention has been given of late to the scour of sewers by water; but it is most certain that too little attention has been given to the considerations last stated, for nothing has been done to relieve the drains and sewers of their worst offence. The evolution of foul and noxious gases in the *drains* is certainly not prevented by scouring the *sewers*. In the meantime the poison exists under foot, and exudes at every pregnable point within and about our houses, and it rises at every grating in our streets, though the senses may become dull to them by constant suffering.

Now this is an evil which can be greatly ameliorated, if it cannot indeed be wholly cured; but it is by a process that, to be effective, must be general, and, therefore, it must be added, compulsory. The process is of familiar application in the ventilation of mines, and particularly of coal mines. An up-cast shaft containing a common chimney flue carried up at the back of every house, and connected with the house-drains at their highest level, would give vent to the foul air in the drains, and discharge it into the upper air. The foul air evolved by heat expands, and expanding it rises, and rising it would be followed by cold air settling down by the gulley gratings in the streets, thus constituting their inlets down-cast shafts, and the sewers and drains themselves channels for the currents setting to the up-cast shafts, by which they would be relieved. The down draft into the sewers would carry with it much soot and fine dust, which would settle upon the liquid current and pass off with it, and so remove some of the tangible as well as the intangible impurities, before referred to, from the air in our streets and about our houses.

Much in this way might be effected by the aid of causes in constant operation; but if the up-cast shaft to every house were also a fire-flue, or were only aided by the draught of a neighboring fire, the up-current would be sufficient not only to prevent the house-drains from retaining foul air, but the foul air would be thrown off into the upper air with better effect and be dissipated innocuously and without offence instead of steaming as it now does from the sewers into the air where it cannot be avoided.

ART. XXVI.—*The Economical Constant Battery;* by Prof. CHAS. G. PAGE, M.D., Washington, D. C.

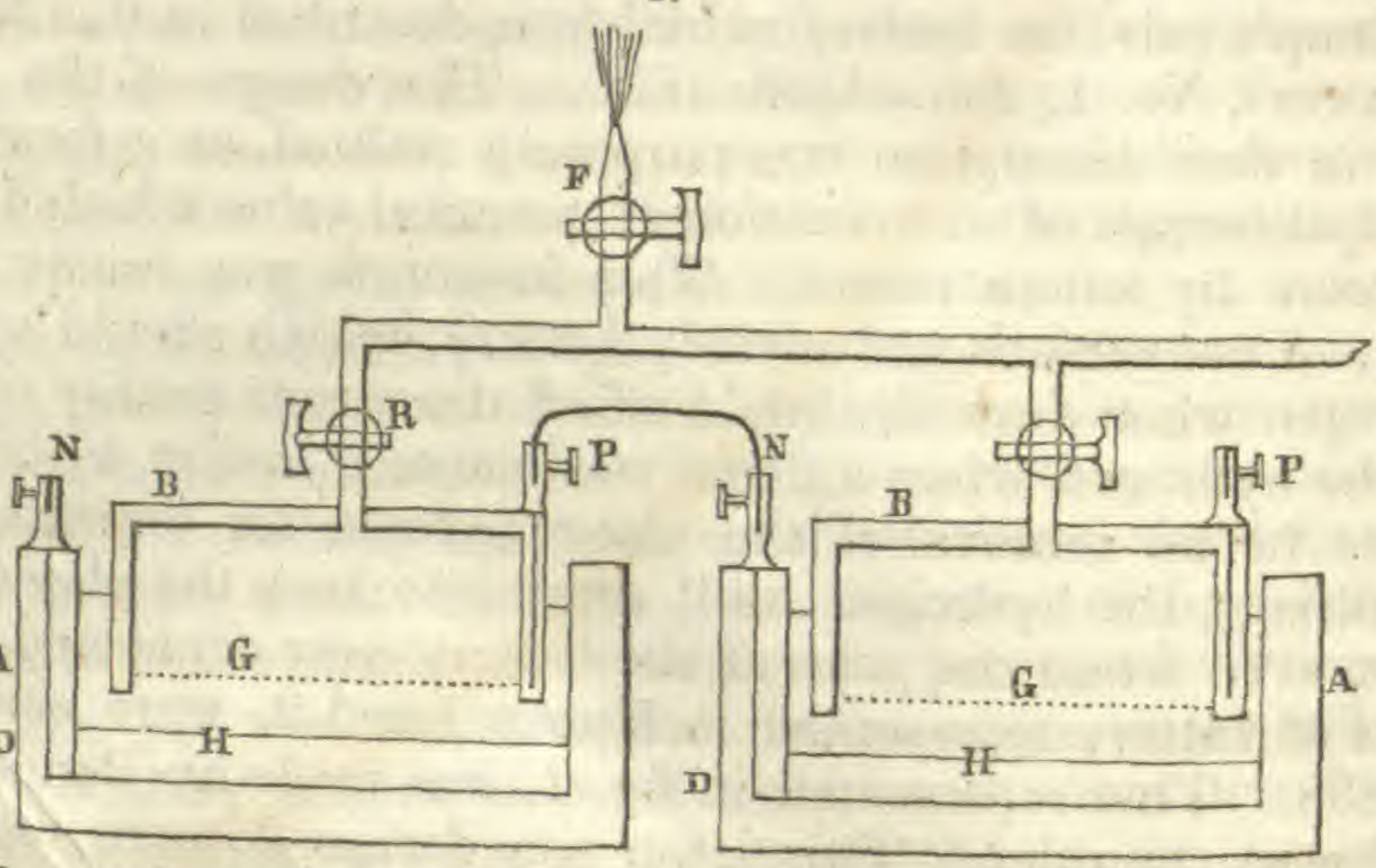
IN the latter part of the year 1837, I invented a modification of Kemp's galvanic battery, which was described in this Journal, vol. xxxvi, No. 1, Jan.–April, 1839. The design of the funnel tube in that description was purposely omitted, as it formed the principal feature of an invention of practical value which I hoped to secure by letters patent. This invention was briefly as follows: A convenient and cleanly battery, which should save the hydrogen when desired, should afford the means readily of igniting the hydrogen when a flame was wanted, and in which there should be no removal of the plates (except for cleaning or replenishing), the hydrogen itself serving to keep the plates out of action even when the poles of the battery were connected. The forms of battery represented in figures 1 and 2, were completed in 1838. That represented in fig. 2, was made by Daniel Davis of Boston, to order. This latter was designed more especially as a substitute for the hydrogen lamp, where the jet is ignited by spongy platinum. The little cage of spongy platinum attached to those lamps is so liable to injury in various ways, and frequently so difficult to supply, that the ignition by the electric spark appeared to be an important improvement to the instrument. After constructing and testing one of these instruments, Mr. Davis informed me by letter, that it involved one difficulty, viz., too much time was required to bring the plates into action, for the purpose of obtaining the spark. I was well satisfied, however, that this was a smaller evil than the frequent loss and expense of the platinum sponge. The form of battery shown in fig. 1, was that adopted for larger operations and the general purposes of galvanic batteries. It is, however, equally well suited, under certain circumstances, to the purposes of the other instrument. The difference between them in this respect is, that in figure 1 battery, the zinc is amalgamated, and in the other it is not. In the first, hydrogen will be supplied only when the poles are joined, and in the second, the hydrogen will be given off at all times except when the acidulated water is below the mouth of the inner receiver.

Fig. 1, exhibits two of the economical batteries constructed upon the basis of Kemp's battery, and involving also the principle of Smee's battery. A is a square box of wood, made tight by pouring into it a quantity of warm shellac* varnish, and pouring it off after the wood has absorbed a sufficient quantity. It

* I have found that a well made box of soft wood may be made very tight by this process, and will last a long time. After the shellac has become thoroughly dry inside, the outside may be painted or varnished.

is an interesting fact, that if the box is varnished or painted outside before the varnish is applied inside, it cannot easily be made tight. Although the rationale is plain, yet the almost universal practice is to cover the outside first. B is an inverted

1.



box of wood prepared in the same manner. G is the negative or conducting plate of the battery, made of wire gauze or a perforated plate. In my first batteries these plates were made of copper, but after the introduction of Smee's battery, I felt satisfied that with Smee's improvement, this form of battery would take precedence of all others where a considerable power was wanted. When copper plates were used, I found that at least two pairs of plates of about ten inches square were necessary to furnish hydrogen fast enough, when the resistance to the current was not very great, to supply a steady flame from the jet. But with a Smee-plate, half the size would have been sufficient. The best material I have found for the plate G, is a perforated plate of platinum platinized; but as this is so expensive, it becomes important to devise some cheaper substitute. Wire gauze of any kind is expensive, and it occurred to me that by precipitating copper upon coarse muslin or millinet, that this might be silvered and then platinized so as to answer. Mr. Mathiot, of the Coast Survey, who has great skill in the management of batteries and the art of electrotyping, informs me that it is perfectly practicable. It is worthy of note here, that Mr. Mathiot has adopted this battery in some of his experiments entirely from his own suggestions, and it is gratifying to me to learn that he thinks highly of it for many purposes. The kind used by Mr. Mathiot is that shewn in fig. 1, except that his vessels are of glass instead of wood, and he had made no provision for leading off or using the hydrogen.

H is the amalgam of zinc.

D its connexion with the wire from N.

P, N, the poles of the battery.

The connection with the zinc is made by a wire passing down through the wood, and the connection with the negative plate in a similar manner. The gas pipes R entering the top of the boxes terminate in a common jet F, where the hydrogen may be burned or led off to a gasometer. If the stop-cocks are supposed to be all open and the battery at work, when the atmospheric air has been driven off and hydrogen comes off at F, the jet may be kindled by a spark from the battery produced by breaking the circuit over the jet. It succeeds best if a helix of a magnet is included in the circuit. When the use of the battery is to be discontinued, the stop-cock F is to be closed, and it is evident that the battery can be so managed that the accumulating hydrogen shall force the liquid out of contact with the negative plate, if that is desired. Although the zinc is amalgamated in the most perfect manner, yet there is always hydrogen enough attached to the two plates and suspended in the liquid to drive the liquid below the negative plate.

In this battery *everything* is saved. There is no waste-zinc, no waste of mercury as in the ordinary process of amalgamation, and the sulphate of zinc and hydrogen are saved. The practical value of such an arrangement will be appreciated more readily from an example. For instance, suppose that to produce one horse power for twelve hours, 16 lbs. of zinc were consumed. This would require 20 lbs. of sulphuric acid, and would yield nearly 100 cubic feet of hydrogen, and about 40 lbs. of sulphate of zinc.

2.

The battery shown in fig. 2, is upon the same principle, but where its principal use is for the purposes of the hydrogen lamp, the zinc plate H should not be amalgamated.

A, the glass jar to hold the acidulated water.

B, the inner jar and hydrogen receiver.

G, the perforated negative plate.

E, a wire connected with and supporting the zinc plate.

F, a wire connected with the negative plate.

The stop-cock S and its pipe are connected with one pole of the battery through the medium of the wire of the helix surrounding the electro-magnet, shown in fig. 3.

The spring wire P is attached to the plug of the stop-cock, upon turning which, the spring wires are brought into contact and separated, producing the spark which ignites the jet. The spark from the wires alone is not generally sufficient to ignite the jet, and I have therefore a small electro-magnet concealed within the cover or cap of the jar, and covered well with cement, to protect it from the action of the acid.

A section of the magnet in the cover is shown in fig. 3.

3.

When the battery is first started, to prevent explosion, it is necessary to take the precaution to bend the wires so that the spark may not ignite the jet until the hydrogen comes off nearly pure.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *New varieties of Narcotin.*—Wertheim has discovered that opium contains two new alkaloids homologous with narcotin. Of these the first by the action of potash lime yields methylamin, the second ethylamin, and the third propylamin. The formulas of the three bases are $C_{44}H_{23}NO_{14}$, $C_{46}H_{25}NO_{14}$ and $C_{48}H_{27}NO_{14}$, and the author designates them, methyl-narcotin, ethyl-narcotin and propyl-narcotin. Treated with sulphuric acid and peroxyd of manganese all three bases yield opianic acid and cotarnin; Wertheim considers it highly probable that in this decomposition three different species of cotarnin are produced corresponding to the different narcotins and which may be termed methyl-cotarnin, ethyl-cotarnin and propyl-cotarnin. Wertheim has also found that herring-brine which has the peculiar odor of propylamin actually contains this base in considerable quantity and that the latter may be readily obtained by distilling the brine with a solution of caustic potash.—*Journal für praktische Chemie*, liii, 431.

2. *Equivalent of Phosphorus.*—Schrötter has determined the equivalent of phosphorus by burning amorphous phosphorus in oxygen gas. A mean of 10 determinations which scarcely differ gave as the true equivalent 387·5 on the oxygen, or 31 upon the hydrogen scale. One gramme of phosphorus according to this yields on burning 2·289186 grammes of phosphoric acid. Pelouze's determination—32—is consequently too high.—*Journal für praktische Chemie*, liii, 435.

3. *Production of Cyanid of Potassium.*—Rieken has confirmed by careful experiments the results of Bunsen and Playfair that cyanid of potassium is formed when carbonate of potash intimately mixed with carbon is heated to whiteness in a current of previously heated nitrogen gas. The temperature must be that at which potassium is formed and the nitrogen must be strongly ignited before passing over the mixture. The necessity of fulfilling these conditions will render the process very difficult of execution upon a large scale.—*Ann. der Chemie u. Pharmacie*, lxxix, 77.

4. *Constitution of Human Fat.*—Heintz has published an elaborate and important memoir on the composition of human fat. The conclusions to which he has arrived are stated as follows:

(1.) Human fat does not consist as formerly supposed simply of olein and margarin, but of at least six different fats.

(2.) The first of these fats is contained only in very small proportions, but from an analysis of the acid obtained from it, appears to be identical with the stearophanin discovered by Francis in the berries of cocculus indicus. The constitution and properties of the acid so far as they could be determined, corresponded with those of the stearophanic acid, $C_{36}H_{36}O_4$.

(3.) The second fat is anthropin. The fatty acid obtained from it by saponification is remarkable for its great capacity for crystallization. It separates in broad brilliant crystalline leaves both from the alcoholic solution and when it passes from the liquid to the solid state. Its constitution appears to be represented by the formula $C_{34}H_{32}O_4$, but further investigations must be undertaken to place the correctness of the formula beyond a doubt.

(4.) The third fat is margarin which yields by saponification margaric acid, $C_{34}H_{34}O_4$.

(5.) The fourth is palmitin which yields palmitic acid, $C_{32}H_{32}O_4$.

(6.) Palmitic acid is identical with the acid which is obtained by the action of fused potash upon oleic acid and which Varrentrapp termed olidic acid.

(7.) The fluid portion of human fat consists essentially of olein. It contains however at the same time a small portion of another fat which by saponification yields an acid the baryta salt of which differs in constitution and properties from oleate of baryta.

(8.) The solid substance which separates during the winter from the fluid parts of human fat expressed during the previous winter, contains a considerable quantity of free fatty acid. Human fat must therefore undergo a gradual decomposition by which the glycerine is gradually destroyed and the fatty acid separates, a species of decomposition long since observed in those fats the acids of which are volatile and which plays a part in the changes of butter.—*Pogg. Ann.*, lxxxiv, 260.

W. G.

5. *On Schönbein's Ozone;* by Professor FARADAY, (Proc. Roy. Soc., June 13, 1851.)—The object of the speaker was to give a brief account of the present state of this subject; taking at the same time notice of the ancient facts which belong to it, and the high hopes of progress which it offers for the future. Ozone is produced when the electrical brush passes from a moist wooden point into the atmosphere, and indeed in almost every case of electrical discharge in the air; or when water is electrolyzed, as in the case of a dilute solution of sulphuric acid or sulphate of zinc; or when phosphorus acts at common temperatures on a moist portion of the atmosphere. For the latter case, take a piece of clean phosphorus about half an inch long, which has been recently scraped; put it into a clean two-quart bottle, at a temperature of about 60° F., with as much water as will half cover the phosphorus; close the mouth slightly so that if inflammation take place no harm may happen; and leave it. The formation of ozone will quickly occur, being indicated by the luminous conditon of the phosphorus, and the ascent of a fountain-like column of smoke from

it. In less than a minute the test will show ozone in the air of the bottle, in five or six hours it will be comparatively abundant; and then the phosphorus being removed and the acids formed at the time washed out, the bottle may be closed and made use of when required for experiments.

The test for ozone is as follows: 1 part of pure iodid of potassium, 10 parts of starch, and 200 parts of water are to be boiled together for a few moments. A little of this preparation placed on writing paper with a brush being introduced into the ozone atmosphere is rendered instantly blue from the evolution of iodine:—or if bibulous paper be dipped into this solution, and then dried, it forms Schönbein's Ozonometric test: for a slip being introduced dry into an atmosphere supposed to contain ozone, after remaining there a longer or shorter time, on being removed and then moistened, instantly becomes more or less deeply blue if ozone be present.

Ozone when obtained by the three very different processes described is identical in every respect: its properties are as follows: 1. It is a gaseous body of a very peculiar odor: when concentrated the odor approaches to that of chlorine; when diluted it cannot be distinguished from what is called the electric smell. 2. Atmospheric air strongly charged with it renders respiration difficult, causes unpleasant sensations, and produces catarrhal effects (by acting powerfully on the mucous membranes). Such air soon kills small animals, as mice, when placed in it; so that ozone in its pure state must be highly deleterious to the animal economy. 3. It is insoluble in water. 4. Like chlorine, bromine, and the metallic peroxyds, it is a powerful electromotive substance. 5. It discharges vegetable colors with a chlorine-like energy. 6. It converts phosphorus ultimately into phosphoric acid; it combines with chlorine, bromine, and iodine; it does not unite with nitrogen under ordinary circumstances, but does when lime water is present; and nitrate of lime is formed from which nitre may be readily obtained. 7. At common and even low temperatures it acts powerfully upon most metallic bodies, producing the highest degree of oxydation they are capable of. Lead and even silver is carried at once to the state of peroxyds; arsenic and antimony produce arsenic and stibic acids. 8. It transforms many of the lower oxyds into peroxyds; thus, the hydrate of the oxyds of lead, cobalt, nickel, and manganese become in it peroxyds: the basic oxyd of silver undergoes the same change. 9. It decomposes rapidly the solid and dissolved protosalts of manganese; the hydrated peroxyds of the metal being formed, and the acid of the salts evolved. 10. It decomposes the solution of the tribasic acetate of lead; the peroxyd of that metal and the ordinary acetate being formed. 11. It rapidly converts the protosalts of iron and tin into persalts. 12. It destroys many hydrogenated gaseous compounds; the combinations of hydrogen with sulphur, selenium, phosphorus, iodine, arsenic, and antimony are thus affected. It appears to unite chemically with olefiant gas in the manner of chlorine. 13. It instantly transforms the sulphurous and nitrous acids into the sulphuric and nitric acids, and the sulphites and nitrites into sulphates and nitrates. 14. It changes many metallic sulphurets (as those of lead and copper) into sulphates. 15. It decomposes many iodids in their solid and dissolved state. By its continued action iodid of potassium becomes converted into iodate of potassa. 16. It changes both the crystallized and dissolved yellow prussiate of potassa into the red salt, potash being evolved. 17. It produces oxydizing effects upon most organic compounds, causing a variety of chemical changes; thus guaiacum is turned blue by it. From the above enumeration it would appear that ozone is a most ready and powerful oxydizer, and in a great number of cases acts like Thenard's peroxyd of hydrogen, or chlorine, or bromine.

A number of the actions of this body, such as the bleaching of indigo and litmus, the peroxydation of metals, the conversion of sulphurets into sulphates, &c., were shown, to illustrate the chlorine-like action of the ozone; and many illustrations supplied by M. Schönbein himself were exhibited.

With respect to the nature of this body, the two chief ideas are—that it is a compound of oxygen analogous to the peroxyd of hydrogen, or that it is oxygen in an allotropic state, *i. e.*, with the capability of immediate and ready action impressed upon it. When an ozonized atmosphere is made as dry as possible, and then sent through a red hot tube, the ozone disappears, being converted apparently into ordinary oxygen, and no water or any other result is produced. This agrees with the known fact, that heat prevents the formation of ozone, and also with the idea that ozone is only oxygen in an allotropic state. To show that heat prevents the formation of ozone a little voltaic battery was associated with a fine platina wire helix, insulated, and connected with the electrical machine; at first the circuit between the battery and the helix was left incomplete; and then on working the machine the brush thrown off from the helix affected the test paper, before described, by the ozone in it; but when the connection was complete, so that the helix was ignited, then the electrical brush from it had no power of producing any effect of ozone.

The speaker described the presence of ozone in the atmosphere, the mode of testing its presence, and the probable effects it produced there. He referred to Schönbein's recent experiments in the insulation of the oxygen of the air and the peculiar effects produced by this action. He showed by experiments, the more recent results of the association of oxygen by light with oil of turpentine and other bodies; and the production of bleaching compounds vying with the hypochlorite of lime in energy. He made it manifest by experiment, that when ether vapor is mixed with air, and a hot platina wire or glass rod introduced, the ether in becoming partially oxydized to produce acid, also produces ozone, the results bleaching indigo powerfully; and he stated that sulphurous acid, ether, tartaric acid, and many other substances which being first mixed with air or oxygen were then exposed to sunlight, exerted bleaching powers often of a very high degree. The evening concluded with the expression of certain theoretical expectations, or rather possibilities, which were put forth as indicating the probable fertility and importance of the subject, and fitted to excite such philosophers as were engaged in the consideration of the physical qualities of the particles of matter to examine how far the phenomena of ozone might be carried onward in the illustration and extension of their researches.

II. Mineralogy and Geology.

1. *On a locality of Carbonate of Strontian;* by Prof. O. Root.—This interesting mineral has recently been found in the rocks of the Clinton group in Oneida Co., N. Y.; it there occurs in geodes associated with the sulphate of strontian. The carbonate occupies the outer part of the geode and envelops the sulphate; in some instances it forms a white coating spread upon the blue crystals of sulphate, making very pretty cabinet specimens. The sulphate of strontian associated with carbonate of iron, calcareous spar, quartz crystals and sulphate of barytes, has long been known from the rocks of the Clinton and Niagara groups, but the carbonate, although ascribed to these rocks under barystrontianite, has heretofore seldom been found by collectors.

Clinton, N. Y., Jan. 9, 1852.

2. *Beryls in Grafton, N. H.;* by Prof. O. P. Hubbard, (communicated for this Journal.)—The highlands between the Merrimack and the Connecticut rivers contain remarkable granitic veins of great width and miles in length.

At one of these veins in Acworth and Alstead, mica is wrought extensively; moreover the feldspar is coming into use for glazing the stone pottery manufactured at Bennington, and is worth when delivered at the railroad on the Connecticut river, $10 a ton. Mica has also been obtained from a vein in Orange on the west side of the mountain, and largely, as is well known, from a vein in Grafton at Glass Hill, two miles south of Orange summit.

About one mile south of Glass Hill is a locality of beryls in a similar vein composed mostly of quartz and feldspar, which seem to have crystallized on an enormous scale and without presenting regular forms, having very large planes of contact with each other. Two beryls were exposed here last summer that for their dimensions are worthy of notice and surpass in bulk and weight any examples of crystallization that I have met with. I arranged to have the one described below as No. 1, taken from the rock; but the means were quite inadequate, and as the structure of the crystal was unfavorable it was ruined; another season under better auspices an attempt will be made, and I trust successfully, to take out No. 2.

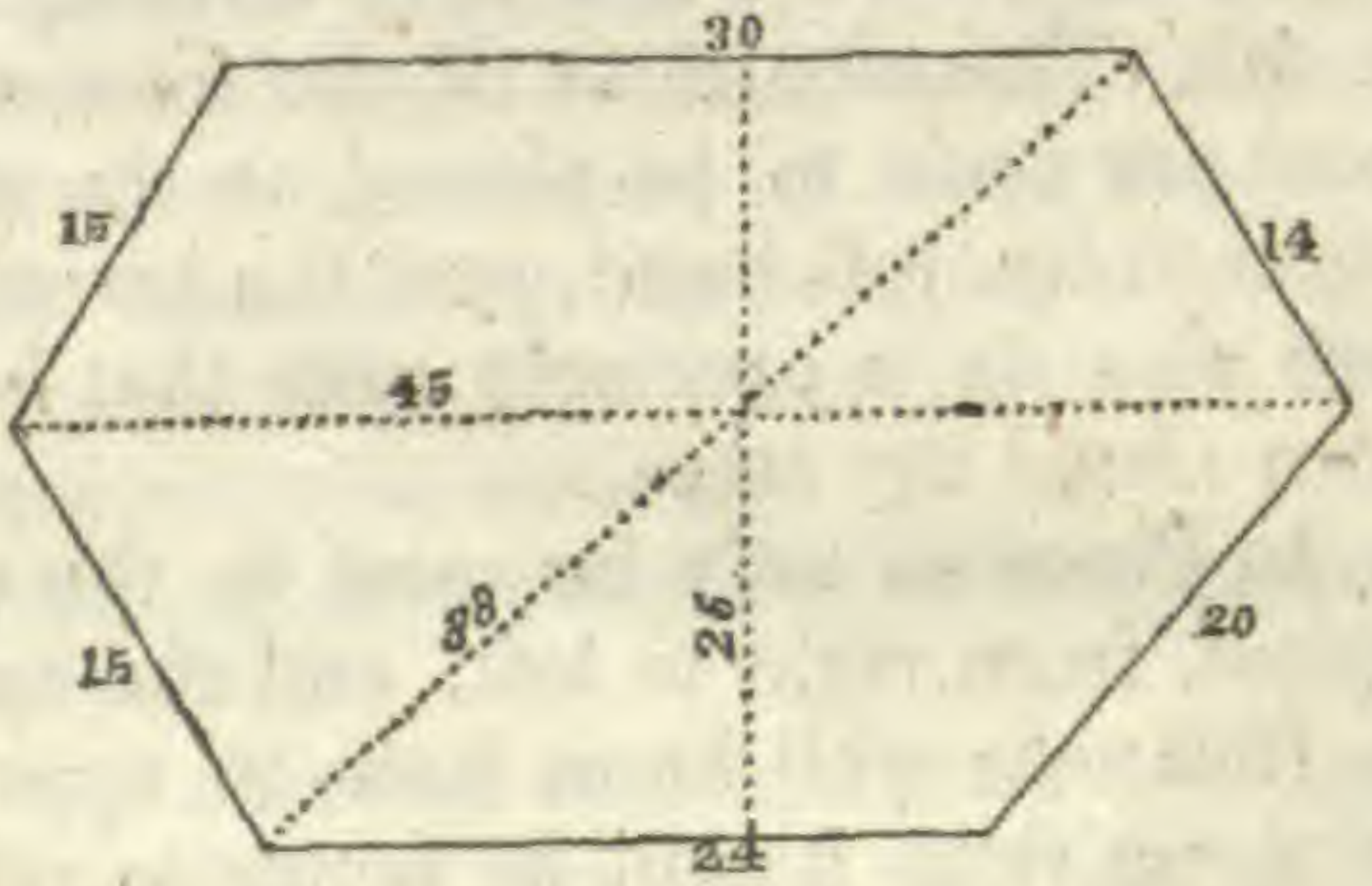
1.

The rock around the beryl, fig. 1, (which lay upon the side S,) had been removed so as to expose all its dimensions. It lay at an angle of 45°, dipping south, and was four feet and three inches long. The rocky mould extended two feet above the base or upper extremity of the crystal, and the diameter was two feet. The crystal was originally six and a quarter feet long. It was quite regular in form, and the upper four feet prismatic and diminishing in diameter one inch in a foot, making the diameter of the base 1·10, the average of the prism. For the remaining two and and a quarter feet, it was distinctly pyramidal, and about four inches diameter at the apex. Some portions of the crystal were very handsome.

It contained subordinate prisms as is usual with these large specimens, and it was seamed transversely here and there with a feldspathic layer.

The other crystal, No. 2, which was near the former, had also been broken off 18 inches, and its superior termination presented the outline and dimensions of fig. 2. The dimensions of both are given in the figures in inches on a scale of one foot to half an inch, and their cubical contents and weight are as follows.

2.



Area of the base of the prism, fig. 1, = 521 square inches = 3·68 square feet; this multiplied by 4 feet, the length of the prism, gives 14·7 cubic feet. Now as 1 cubic foot of water weighs 1000 ounces and the specific gravity of the beryl is 2·675, a cubic foot weighs 2675 ounces, and 14·7 cubic feet will weigh 2445 pounds. The frustum of the pyramid was 27 inches long, width of base 20 inches, of top 4 inches. This gives 434·1 as the area of the base of the frustum, 17·36 as the area of the upper end, and 468 pounds as the weight of the frustum. Hence the weight of the prism is 2445 lbs. + 468 lbs. = 2913 lbs.

The area of the base of the beryl, fig. 2, is 928 square inches = 6·44 square feet. Taking the specific gravity of beryl as before, we have 2675 ounces × 6·44 = 17227 ounces = 1076 pounds as the weight of one foot in length of the crystal.

3. *On Stigmaria*, (Proc. Bost. Soc. Nat. Hist., in Boston Traveller of Jan. 7, 1852.)—Mr. J. E. Teschemacher exhibited a specimen of anthracite coal containing a flattened branch of Stigmaria one foot in length, and three inches in diameter, with the usual markings of cicatrices of foliage, two of which were very perfect.

He remarked that the knowledge hitherto promulgated of this fossil plant, so abundant in all the coal formations, had been chiefly obtained from specimens in the coal measures, but not from those in the coal itself,—and that the opinions of its affinity to the families of plants of the present day varied much. The doubts respecting its nature he thought could only be dispelled by instituting close comparisons, and this he proposed to do between what was already known on the subject, the fossil specimens on the table, and our well known tree, Picea balsamifera, of which he produced fresh specimens:

1st. The cicatrix of the leaf as shown in the perfect specimens on the coal, when examined with a good Coddington lens, agrees minutely with those of Picea, except in size: the fossil being $\frac{1}{8}$th, the recent $\frac{1}{16}$th of an inch in diameter,—the cicatrices of Picea are persistent even on old wood.

2d. The form of the leaf of Stigmaria, as given in figures in the various publications, is linear with an obtuse termination, a midrib, and thickness at the edges produced by involution of the margin:—such is the leaf of Picea.

3d. In the fossil, the leaf is sessile or without petiole, as in Picea.

4th. In Göppert's work, Gatt. Foss. Pfl., 1 and 2, tab. 10, fig. 10, is a figure of a forked branch of fossil Stigmaria, with the cicatrix of a leaf at the angle of the fork; this leaf may be seen in just that position in Picea, and existed in most of the branches Mr. Teschemacher had examined. This is a very striking resemblance.

5th. The cicatrices of the leaves in the specimen on the anthracite coal are seen to be placed on the stem in a spiral direction, from the right to the left hand, and the termination of each spiral, that is where one cicatrix is precisely over that beginning the spiral, is in the eighth turn round the stem.

In Picea as may be seen in the specimen, the arrangement is also spiral, from right to left, and the spire terminates in the eighth turn.

Botanists well know how to appreciate this character, but in order to spare time it will be better to refer merely to the works of Braun, Martins and Henslow on this subject, observing, however, that the number of leaves of the spiral agrees in the fossil with the recent plant, although the cone of Picea, as the most normal exposition of this character, gives twenty-one.

6th. In the figures of Stigmaria by Lindley and Hutton, copied by Göppert, the branches are represented as proceeding in one plane at right angles with the central stem, and at a short distance branching in forks—this as all know is the growth of the whorls of branches of Picea.

7th. The woody structure of the Coniferæ is very characteristic; the central pith is cellular; there are few spiral vessels, but the chief mass is pleurenchyma or ligneous tissue with glandular markings. Mr. Teschemacher exhibited specimens of charred pine wood for the purpose of comparison with charcoal on the anthracite; it was seen that the resemblance, particularly of the annual rings, is striking. Had the lines on the fossil been made by vessels, as in leaves of Gramineæ, the impression of the vessels, or perhaps, portions of the vessels would appear, as in numerous other specimens of leaves. These markings are what Göppert, in his prize essay, calls the annual rings of Araucaria;—the specimen on the table was by far the finest one in the collection of Mr. Teschemacher.

He observed that he could not measure the weight of evidence necessary to produce conviction in the minds of others, but he felt persuaded that the abundant Stigmaria was the fossil of a Coniferous tree nearly allied to Picea. It might be asked why no remains of cones were found. Mr. T. exhibited a specimen which appeared to him more to resemble the impression of a cone than of any Lepidodendron or Sagenaria hitherto figured, but as he had found only two specimens of this nature, he had not at all a decided opinion on the subject; yet even here the spiral direction was from right to left.

With respect to the existence of numerous fossil fungi in the anthracite, he had already exhibited specimens of the rattan from Singapore, (the Palm tribe,) on the epidermis of which were fungi exactly resembling, both in appearance and mode of growth, those on the anthracite. He now desired to add the following observations.

When the globular masses from the coal (resembling sphæria) were exposed to heat sufficient to burn off the carbon and other matters, much peroxyd of iron remained, as was seen in exhibited specimens;

sulphur is found oozing out in most of them, and particularly on those containing fungi; and of all vegetable productions fungi contain by far the largest proportion of nitrogen. Now chemists are aware that if peroxyd of iron, sulphur, and sal-ammoniac which contains nitrogen, are intimately mixed together and heat sufficient to volatilize the nitrogen compound be applied, the result is bisulphid of iron in small brass-colored cubes—precisely such as are seen in these specimens of fossil fungi.

In these specimens of fossil fungi resembling the starfish a few of these cubes may be seen, but in others three or four times this size, the body is a mass of these yellow-colored metallic cubes.

4. *Bulletin of the Geological Society of France.*—The following are extracts from recent numbers of the Bulletin.

Caves of Adelsberg, Magdalena and Planina in the Tyrol.—These caves have been described by Dr. Schmidtl. The cave of Planina in which runs the river Poik, is of vast extent, and seven times deeper than that of Petdelsberg. It contains a lake and several cascades ten feet in height. Dr. Schmidtl had a boat constructed to explore the inner regions, but met with obstacles in the fallen earth that prevented his progress. The water is very deep and the stalactites often hang so low, that it was necessary to lie down in the boat to pass. The masses of fallen debris are often 80 to 100 feet in height; and as the water passes below them, the voyager has to climb over these islands dragging his boat after him. M. Fitzinger has described from these caves seven species of Proteus, specimens of which are exceedingly abundant; and M. Kollar has found and described some eyeless Crustacea. Dr. Schmidtl's description and plans of the caves will be published in the Memoirs of the Vienna Academy.—p. 158, January 13, 1851; *in a letter from M. Boué.*

A Cavern with Bones recently discovered at Lauw (Haut-Rhin), by M. A. Daubrée.—The jurassic limestone of the vicinity of Lauw, pertains to the lower oolite and constitutes a group of low hills situated adjoining the ancient strata of the Vosges. There are several caverns along the banks of the Dollern, and one recently opened is of great extent, with a series of large chambers, connected by narrow passages. From the entrance gallery four transverse galleries pass off, one of which has been followed for ninety yards. Stalactites are abundant; but in the interior there are no animal remains except refuse from animals that now occupy the cave. But at the entrance of the principal cavern, from six to ten yards above the river, there is a yellowish clay, abounding in calcareous concretions, and among them bones, which according to MM. Lereboullet and Schimper belong principally to species of Ursus. There is also the debris of the wolf, fox and wild boar. The bone clay is covered a yard thick with sand containing calcareous concretions and no bones; and it was obvious that the origin of the deposit was anterior to the present epoch.—p. 170, Jan. 13, 1851.

Geodes filled with water, at St. Julien de Valgague; by M. D'Hombres-Firmas.—The inferior formations of the middle oolite of this region contain specular iron, and still more abundantly, the hydrated oxyd of iron, the latter in concretions. In a clay which occurs in these beds, there are occasional nodules usually four to six inches in diameter, and often larger, some of which contain within a fine drusy crystallization, and others a large quantity of water. On long exposure to the air the latter lose the water; but fresh nodules will sometimes afford three quarts or more. This water when poured out deposits a little calcareous earth and clay, and afterward the tests show the presence of some sulphate of iron.—p. 174, Jan. 13, 1851.

Researches on the origin of the present state of the terrestrial globe, or its crystal-like cleavage; by M. DE HAUSLAB.—This author after discussing the direction of mountains, and of dykes and cleavages among rocks, deduces some general principles with regard to their direction, and then explains his hypothesis that the surface of the globe presents approximately the faces of a great octahedron. In an octahedron there are three axial planes intersecting one another at right angles; and the positions of the circles on the earth's surface which he lays down as the limits of these planes (or their intersection with the surface) are as follows. The *first* circle is that of *Himalaya and Chimborazo*, passing from Cape Finisterre to the Himalaya, Borneo, eastern chain of New Holland, (leaving on its sides a parallel line in Malacca, Java and Sumatra,) to New Zealand, thence to South America near Chimborazo, the chain of Carracas, the Azores to Cape Finisterre. The *second*, passes along the South American coast and the north and south ranges of the Andes, the mountains of Mexico, the Rocky mountains, Behrings' Straits, the eastern Siberian chains, going to the south of Lake Baikal, near Kiatcha, the Altai, Himalaya, the mountains of Bombay in Hindostan, a point in the northeast of Madagascar (where the summits are 12,000 feet high), the mountains of Nieuwefeld, 10,000 feet high, Cape Caffres, Cape Moro de Saint Martha, to Brazil, the rapids of La Plata, Paraguay, Parana, the elevated basin of Titicaca, the Andes, Illimani near Jaen and the defile of Maranova. The *third* circle cuts the two preceding at right angles, and passes by the Alps, the islands of Corsica and Sardinia, along the basin of the Mediterranean, the mountains of Fezzan, Lake Tschan, the Caffre mountains of Nieuwefeld, the Southern Ocean near Kerguelen's Land, the eastern or Blue mountains of New Holland, straits of Behring, Spitzbergen, Scandinavia, Jutland, etc.

These three great circles point out the limits of the faces of the great hypothetical octahedron. Each of the faces may be divided into eight others by means of lines of accidents of minor importance, so as to make in all forty-eight irregular triangles, a form of the diamond. At the intersections, M. de Hauslab observes that there are nodes of dykes, and along the lines or near them, all the mountains of the globe occur. The author gives an extended illustration of his subject and afterwards considers the particular history of the configuration of the earth's surface in accordance with his hypothesis.

M. Boué who adopts similar views adds as a note, that we should remember in this connection that the metals crystallize either in the tesseral or rhombohedral systems, and that native iron, the most common constituent of meteorites, is octahedral in its crystals.—pp. 178–194, Jan. 20, 1851.

M. Boué afterwards states in a letter addressed to M. Viquesnel, that the hypothesis that the surface of the earth may lead to the idea of the globe's being a polyhedral crystal instead of a sphere was brought out by La Metherie in the Journal de Physique, xvii, 251; xlii, 132; xliii, 355; xlviii, 66; lxxi, 172, 382; lxxviii, 241; lxxxi, 288; and in his *Theory of the earth* in 1795 and his *Lessons on Geology;* also by Oken in his Lehrbuch der Naturphilosophie, 1809, pp. 149, 154; by R. Jameson, Mem. Wern. Nat. Hist. Soc. Edinb., 1814, ii, 221—p. 273, March 17, 1851.

On a Hydrobarometer, a new instrument for ascertaining the depth and temperature of the Sea; by M. H. Walferdin.—M. Walferdin shows that the bulb of an ordinary thermometer, formed by being blown on the extremity of a tube, is compressible between the finger and thumb so far as to cause the mercury to ascend appreciably, and that consequently the ordinary arrangement for ascertaining the temperature at depths is faulty. At the artesian well of Grenelle, before the jetting of the waters, six *maxima* thermometers ("thermometers à maxima à déversement" of M. Walferdin*) protected from pressure and sunk to a depth of 505 meters, indicated as the mean temperature 26°·43 C. A seventh thermometer at the same time was sunk, unprotected from the pressure, and it indicated 39°·50 C. A pressure of 50·5 atmospheres had thus increased the result by 13°·07 degrees, equivalent on the arbitrary scale of the instrument to $\frac{1}{4}°$ an atmosphere. This experiment was performed by Arago and M. Walferdin.

It hence follows that a *minima* thermometer, protected from the action of pressure, will indicate the true temperature of depths; while a *maxima* inverting thermometer exposed to the pressure, and sunk with the other, may indicate the pressure of the sea. Such is the principle upon which M. Walferdin constructs his new instrument which he calls a *hydrobarometer.*

The best means of avoiding the effects of pressure on a thermometer, according to careful trials, is by enclosing the instrument in tubes of glass, more or less thick according to the pressure they will have to endure, and hermetically sealing the tubes.—p. 214, Feb. 3, 1851.

On Mount Ararat; by M. Abich.—The great Ararat stands to the southeast of little Ararat; and the two are situated in the longer axis of an elliptic volcanic system, and at the centers of the ellipse. This system occupies a plain, gently inclined to the northeast, which forms the natural slope between the high plain of Bajazed and that of the Araxes, the former 865 yards, the latter 1608 yards in height. The great Ararat has in its upper part the form of a segment of a cone, slightly curved, and truncated towards the northeast, opening towards the Araxes. Ararat viewed on the side of the Araxes is a broad-backed mountain of imposing grandeur owing to its breadth and the wild features of the crater shaped-cavity it encloses; while on the other sides it has the regular form of a pointed cone.

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* M. Walferdin's inverting thermometer is filled to the point with mercury, and the increase of temperature or action of pressure is shown by the amount of mercury which passes the point and is reversed. The instrument, he observes, is easily adjusted with the mercury to the point, at the temperature of the surface of the sea; and after the experiment, it is to be subjected to the same surface temperature, when the quantity of mercury failing, will be read off on the scale. The maxima thermometer in his experiments here mentioned, is used simply for the measurement of pressure, or as a barometric instrument.

The gorge of St. James impresses upon Ararat the appearance of a great crater of elevation. The interior structure of the mountain is here exposed to view, showing trachytic rocks containing pyrites, arranged either in irregular beds or in extensive masses of conglomerates. There are however no modern lavas. These are found along the longitudinal axis of the system, and form two eruptive regions at opposite extremities of the line. That to the *north* includes a conical mountain of regular form, and the whole region (called Kipgoell,) appears to be a product of successive volcanic eruptions. It terminates in a plain having a height of 3248 meters (3552 yards) which is richly covered with vegetation excepting a lava region near its center. Here are two vast crateriform cavities near the place of ejection, looking like deep gulfs of subsidence, and exposing a succession of layers of compact lava beds alternating with beds of scoria. On the *south* side, the volcanic action has opened a large gorge in the flancs of the great Ararat, which may be traced to the top making an elongated niche or gorge which extends downward and enlarges to its base. Below these is a plain like that of Kipgoell, with a similar crateriform pit or gulf. There is a long series of cones of eruption upon the eruptive band which communicates with the aforesaid gorge, several of which are regular cinder or scoria cones and have ejected streams of lava. Other hills of scoria have no craters.

The part of the mountain between the two regions of eruptions is comparatively easy of ascent. M. Abich made his first attempt on the 16th of August, 1844, but was repulsed by a heavy storm. Again on the 23d, he encountered another terrific storm, accompanied with electric discharges of great intensity, and so powerful was the electrical movement that for a long time small phosphorescent flames were seen going from the extremities of several metallic instruments and fluttering from the iron heads of their canes whenever they gave them a vertical position. A fall of snow continued through the night till 10 the next morning and covered the whole cone with sleet to more than a foot in depth, making the route extremely slippery, and that of their ascent thus far nearly impassable. A third attempt was made on the 3d of September; but was unsuccessful on account of the ice.

Again on the 28th July, 1845, M. Abich made his fourth trial, and reached the top at noon on the 29th. The top corresponds to the most elevated part of the west side of a great crater of elevation. This side has the character of a back with a gently rounded and undulated surface, and varied with several low hills, running in a line nearly northeast and southwest. The two middle hills are the proper top of Ararat; the left one was visited by Parrot.

The neck between the great and little Ararat is low and flat and includes a perfectly horizontal plane about 550 yards broad. The debris on the summit of little Ararat consists of fragments of a rock like the Andesite of South America.—p. 265, March 3, 1851.

Water Spouts.—M. Boué describes three water spouts, which he observed, while on a neighboring mountain to *rise from* the surface of Lake Janina. His sketches represent three oblong inverted cones resting on the lake and terminating abruptly above; and he says that the cones or funnels were empty within, as he could look down into them from the elevated place where he stood. The day was clear and hot, and there were neither clouds nor wind. The particles of water in the cones had a spiral motion from east to west with a linear progress from south to north.—p. 274, March 17, 1851.

Among the many others papers in the Bulletin there are the following: *On the Jurassic, Cretaceous and Nummulitic formations of Bithynia, Galatia and Paphlagonia;* by M. P. de Tchihatcheff.—pp. 280–312, with a map, March 17, 1851. *Silurian fossils of the vicinity of Rennes;* by M. Marie Ronalt.—pp. 358–389, April 21, 1851.

5. *Memoires de la Société Géologique de France*, 2nd ser. vol., iv. Part 1. 202 pp. 4to, with 11 plates. The first memoir is on the fossils of the secondary period collected in Chili, by J. Domeyko, Prof. Chem. de Geol. et de Min. á l'Univ. de Coquimbo, and on the strata to which they belong, by MM. Bayle and H. Coquand. The fossiliferous beds of Copiapo are shown to belong to the upper lias and lower oolite. The beds of the Andes of Coquimbo, rise to a height of 5000 metres above the sea. At Porteruelo de Doña Ana, they reach 4094 meters and belong to the middle oolitic period. At Arqueros, the beds contain *Crioceras Duvalii* and *Ostrea Couloni*, species characteristic of the Neocomian formation of Europe. The rocks called Jurassic by these authors were considered Cretaceous by D'Orbigny in his work on South America; this formation appears to be of great extent in Chili and is found also in Peru.

The 2nd memoir (150 pages) is upon the Gneissic formation of La Vendée, by A. Rivière. The 3d, on a new Pyrenean type parallel with the true chalk, by A. Leymerie.

6. *Researches in Terrestrial Physics;* by Henry Henessy, M.R.I.A., etc., (Phil. Trans., Part 2, for 1851, pp. 495–547.)—Prof. Henessy in his Researches, has brought to bear the higher mathematics upon various questions connected with the changes in a globe cooling from fusion, its figure, mode of cooling, structure of the crust and nucleus, thickness and fractures of the crust, and other points. We can only in this place call attention to his profound investigations into this branch of terrestrial physics. The author shows in the course of his paper that the solidification of the globe could not have begun at the centre, and on the contrary must have gone on from the surface, adding successive layers of cooled rock. He deduces that the least possible thickness of the crust is 18 miles, and its greatest possible thickness, 600 miles. To arrive at this result, Prof. Henessy employed expressions that he had obtained, "in which the variation of gravity at the earth's surface is a function of the radius and ellipticity of the fluid nucleus supposed to exist within it," thus affording a method of deducing "the limiting values of that radius, and consequently, of the thickness of the solid shell."

The value of the earth's ellipticity when entirely fluid, as obtained by Prof. Henessy, was $\frac{1}{302 \cdot 22} - \frac{1}{316}$; its primitive ellipticity was therefore a little less than its present ellipticity.

The author infers also that a considerable amount of friction and pressure must exist between the shell and fluid nucleus. Still, the highly crystalline structure which must characterize the shell's inner surface, combined with the viscidity of the strata of the nucleus in immediate contact with it, would tend to equalize the motions of both shell and nucleus, and to cause the whole to rotate as one mass.

It is also shown that if the rotation of the earth were originally stable about its axis, it would continue to rotate in the same way forever.

With regard to the lines of elevation on the earth's surface, he observes, that if a zone of least disturbance existed near the parallel of mean pressure, the directions of great lines of elevation should be nearly parallel or perpendicular to the equator. But as yet, observation seems to prove that such a zone does not exist on the earth's surface; and hence, from Section VIII, in his paper, it provisionally follows "that the constant pressure greatly predominated over the variable pressure, and consequently, that the direction of lines of elevation must be comparatively arbitrary. Geological and geographical observations present results which are generally in accordance with these views."

7. *Remarks on the Topography of the State of New York;* by Prof. GUYOT, (from Prof. Guyot's Report on the various Meterological stations established in New York, in the Rep. Regents Univ., 1851, 232.)—The main mass of the state of New York may be said to be a high triangular tract of country, or table-land, elevated from 1,500 to 2,000 feet above the ocean. It may be considered as the northwestern extremity of the plateaux which form in this latitude the western half of the great Apalachian system. The natural limits of this massive belt are, in the west and north, the large depression partly filled with the waters of the great lakes, Erie and Ontario, and which continues its northeastern course down the St. Lawrence to the ocean; in the east the long and deep valley occupied by the Lake Champlain and the Hudson river. But in the south the table-land continues uninterrupted into the state of Pennsylvania. The eastern edge, along the Hudson and Champlain valley, is formed by a series of chains of mountains, more or less isolated from each other, which bear the highest summits in the state, the highlands which cross the Hudson, the Shawangunk mountains and the Catskill on its western banks, and the system of the mountains of Adirondac in the neighborhood of Lake Champlain. Beyond this eastern wall, the true mountain chains cease; but the surface of the western plateau is indented by valleys, the bottom of which is generally several hundred feet below the general level, and which have between them high ridges. A last feature, which is not the least remarkable, is a deep transversal cut, forming the valley of the Mohawk and of Lake Oneida, which opens a way from the low country around Lake Ontario to the Hudson valley, through the whole belt of table-land, and separates it into two distinct masses.

The state is thus naturally divided into four great physical regions to which we must add a fifth, that of the sea shores. They are,

1. The southern, or maritime region.
2. The eastern, or the region of the Hudson river and Champlain valley.
3. The western, or the region of the western plateau.
4. The region of the great lakes, Erie and Ontario.
5. The northern, or the region of the plateau and mountain of Adirondack.

I beg leave to state, in a few words, the general character of each of them, and to indicate the meteorological stations placed therein.

(1.) The *southern or maritime region* contains New York city and its neighborhood, especially Long Island, and may be extended as far as Westchester county, no part of it being scarcely more distant from the sea shore than twenty-five miles. This region, with its flat and sandy beaches, its low grounds surrounded by water, only occasionally varied by inconsiderable hills which never rise higher than several hundred feet, is entirely open to the influence of the sea winds that sweep over it without obstacle. This circumstance, and the southern exposure, give it the highest mean temperature within the state. Six stations belong to this region. Erasmus Hall, at Flatbush, at the western, and East Hampton, at the eastern extremity of Long Island, are believed to manifest the extreme character of the maritime climate of the coast. North Salem, somewhat in the interior, will show, perhaps, the limit of the immediate influence of the sea. The remaining three belong to the city of New York; they are the Deaf and Dumb Institution, Rutgers Institute, and the Free Academy. These three stations being very near each other, and in similar circumstances, it has been thought better that they should observe at different hours, and make together a more complete series of bi-hourly observations.

(2.) The *eastern*, or the region of the Hudson valley, is a long but narrow strip of land on both sides of the Hudson river, stretching from north to south, surrounded first by hills and low table-lands as far up as the gorges where the river crosses the highlands. The valley widens, higher up, in the extensive plains on the eastern side of the river, which are elevated only some hundred feet above tide water. Notwithstanding this low situation, its climate is generally more severe than could have been expected, owing, no doubt, to the cold northern winds which flow from Canada and Labrador, along the open valley of Lake Champlain, as in a natural channel. The stations are Newburgh and Albany, on the western banks of the river, and Hudson, which will probably be transferred to Kinderhook, in the eastern plains.

(3.) The *western* region, or the high table-lands, between the Hudson valley and Lake Erie, is the most extensive. A depression of the surface, and the change of direction of the general slopes, well expressed by the course of the two main branches of the Susquehanna, seem to indicate a natural division of it into two parts of almost equal extent, the eastern or middle table-land, and the western plateau. They are separated by the deep valleys of Cayuga and Seneca lakes, which cut the whole mass almost through from north to south.

The middle plateau, the eastern edge of which is formed by the mountainous country of the highlands, the Shawangunk and the Catskill, has its greatest elevation in the neighborhood of these chains, at the various head waters of the Delaware, where it rises to a mean elevation of 2,000 feet, and on the heights, close along the south bank of the Mohawk valley, at the head waters of the different branches of the Susquehanna. In this latter portion, the passages from the valley of the Mohawk up to the table-land, show still an elevation of 1,400 to 1,500 feet. The general slope inclines toward the southwest, as the direction of the rivers indicate; and the watercourses, the sources of which are the deep valleys of the Mohawk and of the Hudson, seem to avoid flowing into them, and take an opposite course towards the western waters. But arrested by the rising mass of the western plateau, the Susquehanna and the Delaware turn suddenly back, enter the chains of the Apalachian system, cut them through at several places, and find their winding way to the Atlantic ocean. The exposure of the plateau toward the southwest opens it to the moist southwest winds, and gives it, perhaps, a larger supply of rain.

The western table-land is characterized by a remarkable swell of land, the mean height of which ranges from 2,000 to 2,500 feet. It attains its greatest elevation in the southwestern part of the state, and beyond the state line in Pennsylvania, and continues, though rapidly declining, along the southern shores of Lake Erie. This is the region of the watershed. From these heights the waters flow down their slopes in every direction, and reach the Atlantic ocean by three different basins, that of the St. Lawrence, by the Genesee river and Lake Erie; that of the Susquehanna by the Chemung river, and that of the Ohio and Mississippi, by the Alleghany river. Unlike the middle table-land, the portion of this western plateau belonging to the state of New York, inclines towards the north, as the course of the Genesee river already indicates. In the south part of it, in Chautauque, Cattaraugus and Alleghany counties, the bottom of the valleys has still an elevation of 1,400 to 1,600 feet above the ocean. Farther north, Erie and Wyoming counties make a lower terrace, of only 1,000 feet elevation, which fall rapidly down to the plains of Buffalo, Rochester and Syracuse, an elevation of from 500 to 600 feet above tide water, and from these, by a last step, to the lower level of Lake Ontario, 235 feet above the ocean. In the southwest, the plateau shows a still more abrupt slope; from the heights where lake Chautauque lies (1,300 feet) it descends 700 feet down to Lake Erie, 565 feet within the short distance of seven miles.

The stations in the middle plateau are distributed as follows: on the higher grounds, along the eastern ridges, Liberty in Sullivan county, at the head of Mongaup valley, and Delhi, Delaware county, in the upper valley of the Delaware. On the heights of the watershed, along the valley of the Mohawk and Erie canal, Cherry Valley, in Otsego county, at the head of the Susquehanna; Hamilton College, at Clinton, Oneida county; Pompey, on the summit of the ridges, above Syracuse. In the valley of the Mohawk, Canajoharie and Utica. In the interior, Oxford, in the Chenango valley; Cortland Academy at Homer; Newark valley, furnished by the Smithsonian Institution, and Ithaca in the deep valley of Cayuga lake.

Most of these places, though in elevated situations, are nevertheless placed in valleys, and surrounded by heights, which situation may have a marked influence, especially on the course of winds. This was unavoidable, the villages, where the Academies are established, lying generally in the fertile bottoms along the watercourses. But it were highly desirable that some stations should be established in a free elevated position, such as that of Pompey. Meredith near Delhi, at the very summit of the watershed between the Delaware and Susquehanna rivers, over 2,000 feet above the sea level, would be such an one. I consider it very fortunate that a good and reliable observer, Samuel A. Law, Esq., is ready to undertake the observations, if furnished with instruments. I take the liberty of strongly recommending that this should be done. Meredith will be the highest station in the state, and, with Pompey, the most advantageous for ascertaining the course of the winds.

The western plateau being less settled, the stations are less in number. Three only are situated on the high terrace in the south: Elmira, Alfred Academy, and Jamestown. It were desirable to add two others in the middle part, for instance on the heights of Springville, and at Geneseo in the valley of same name.

(4.) The *region of the great lakes* is reduced, along Lake Erie 565 feet above the ocean, to a narrow strip along its banks; but from the eastern extremity of this lake, it becomes a broad and fertile plain, elevated from 400 to 600 feet above tide water, and 150 to 300 feet above Lake Ontario. It extends itself from Buffalo and Rochester to Lake Oneida. In the western half, this terrace falls by an abrupt and rapid step, marked by the falls of Niagara, down to Lake Ontario, 235 feet above the ocean; and farther east by gentle slopes. It is in this region that the meterological influence of the lakes is more particularly felt. Seven stations belong to it. Fredonia and Buffalo on Lake Erie, Rochester, Geneva College, Seneca Falls and Syracuse in the plain, and Mexico near Lake Ontario. A station was established at Lewiston on the Niagara, near the lake; but the Academy having been broken up, the station has been discontinued after nine months existence.

(5.) The *northern region* is a large tract of country isolated all around by the valleys of Lake Ontario and the St. Lawrence, of Lake Champlain and the Hudson and of the Mohawk. The mean elevation of its central part is from 1,500 to 1,700 feet. It rises rapidly from the Mohawk valley, from Lake Champlain and Lake Ontario, but by very gradual and gentle slopes from the St. Lawrence. Like the table-land south of the Mohawk, the eastern portion is mountainous. Five or six chains nearly parallel, run from S.S.W. to N.N.E., and fill the whole space, 50 miles wide, between Lake George and Lake Champlain and Longlake. This is the group of the mountains of Adirondac, which terminates abruptly in the parallel of Plattsburgh. They are the highest mountains in the state, many of their peaks rising over 5,000 feet above the ocean; they intercept numerous valleys, which are partly filled by a great number of lakes, and give rise to the sources of the Hudson and of various other streams. The western part is a high table-land, much more regular and less indented than that south of the Mohawk. One great feature only is to be remarked, that is the large and deep valley of the Black river, the flat bottom of which is 700 to 800 feet below the general level, and as much above the ocean. The country between the Black river and Lake Ontario, the long slopes descending towards the St. Lawrence, the shores of Lake Champlain, and Lake George and the Hudson are settling and clearing rapidly, but the whole central tract is still a wild almost unbroken primitive forest, interspersed with only a few settlements.

In these circumstances it was not to be expected that a station could have been established in the wilderness, in the almost Alpine region of the high plateau, however interesting it would be to fill up in part, at least, this vast meteorological lacune; but thanks to the liberality of Hon. Archibald McIntyre, who furnished at his own expense, the necessary instruments, a post was established at the iron works of Adirondac village, in the very midst of the highest mountains of the group, at the request of the Smithsonian Institution and Dr. T. R. Beck. The other places of observation of the lower country are Glens Falls, on the Hudson, Plattsburgh on Lake Champlain, Malone and Ogdensburgh in the northern plains of the St. Lawrence, Lowville in the Black river valley; Boonville on the watershed between this valley and that of the Mohawk. A station is wanted in the southern part of the table-land in the region of Lake Pleasant, in Hamilton County, but no observer could be found there.

The total number of the above-named stations in the state is thus thirty-eight.

8. *Reports on the Albert Coal Mine;* by C. T. JACKSON, and Dr. J. G. PERCIVAL, with a microscopic examination by Dr. JOHN BACON, and chemical examinations by Dr. A. A. HAYES, J. R. CHILTON, Dr. URE of London, Dr. JOHN TORREY, Prof. JAMES C. BOOTH, and others. 48 pp. 8vo. New York, 1851.—The coal of the Albert mine, New Brunswick, has been called asphaltum. It resembles asphaltum closely in lustre, color and compactness, but differs in chemical characters, and in this respect agrees with a highly bituminous coal. It has been supposed to occupy a vein and this has been one ground for considering it distinct from true coal. The investigations detailed in this pamphlet bear upon each of these points.

Dr. Jackson in his report describes the geological relations of the coal and its chemical characters, and the fossil fish and other fossils of the associated beds. He describes the beds as very much folded and contorted, so as to be vertical in many places; and the coal as included between layers running in accordance with the general stratification of the country. In most cases the rock enclosing the coal is much crushed or broken. Figures of natural sections are given illustrating the remarkable contortions described. The coal, unlike asphaltum, does not fuse when heated to 700 F., but burns like cannel-coal; it does not dissolve in naphtha or benzole, only 14 p. c. being taken up by the former and 20 by the latter. The fossil fish belong to the carboniferous period. The species named are *Palæoniscus Alberti*, *P. Brownii*, *P. Cairnsii*; and others are indicated. The fossil plants are true carboniferous species; one is near the *Lepidodendron gracile* of Brongniart (ii, pl. 15). Dr. Jackson's Report extends over 28 pages.

Dr. John Bacon, after grinding down thin slices of the supposed asphaltum, detected with a microscope vegetable fibrous tissues much contorted, enclosing cells and penetrated by numerous apertures approaching a circular form which appear to be transverse sections of vessels; but the tissues were too much broken to enable him to form a positive opinion in regard to the nature of the plants to which they belonged, though abundantly showing that the material was true coal and not asphaltum.

Dr. Percival was confined to a gelogical examination of the region, and arrived at the conclusion that the coal occupied the position of a true bed. His observations are important, but we can give at this time only his results, which agree with those of Dr. Jackson:

"1st. The bed in question is situated in a bituminous shale, which, from its own fossils, and from its connection with rocks, having the fossils and other characteristics of the coal formation, belongs itself to that formation.

2d. The shale, for a considerable distance around the mine, exhibits great irregularities and contortions, caused by disturbances which have changed its dip from horizontal to nearly vertical.

3d. The principal portion of the mine lies, on the whole, in a direction between the strata, and presents on the surfaces of its walls, appearances of deposition in a soft aqueous condition, and not of a rupture and injection when the rock was indurated.

4th. The irregularities in the mine, even those at the fault, and in the north-east extremity, correspond with irregularities observed in remote parts of the shale, and may be explained by the disturbance necessarily arising from the change from a horizontal to a nearly vertical position of the strata, and perhaps from a contortion in their general direction.

5th. The substance is analogous to cannel-coal and jet, in which the original lamination is nearly or quite obliterated, and which, like all substances which have hardened from a liquid or very soft state, are divided by jointed seams, conforming, in their arrangement, to the bounding walls; and, conformably to this, the jointed seams or divisional planes of the bed, instead of being always horizontal, and unconformable to the walls, are, in every point examined by me, strictly conformable to them.

6th. This substance, when tested by the flame of a candle, and by red-hot iron, or iron heated just below ignition, exhibits the characters of coal, and not those of asphaltum."

Dr. A. A. Hayes compares the chemical characters of asphaltum and the Albert mine coal, and points out the many dissimilarities between them. We here cite a few of those mentioned.

Coal of Albert mine.	Asphaltum.
Specific gravity at 60° Fah., 1·0836–1·1113.	Cuba asphaltum, specific gravity 1·165–1·170.
Powder, black.	Powder of asphaltum, brown.
Does not fuse at 700°.	Fuses completely below 220°.
Less than 10 p. c. dissolved by oil of turpentine at 212° F.	Wholly soluble in oil of turpentine at 212°.
Hardly acted upon by linseed oil.	Wholly soluble in linseed oil.

Dr. J. R. Chilton obtained in an analysis,

Fixed carbon 40·86, volatile matter 58·48, ashes 0·66=100. This is near the result of Dr. C. T. Jackson, who found in different samples,

	Vol. matter convertible into gas and removed by heat.	Coke.
1.	58·8	41·2
2.	61·67	38·33

Dr. Frederick Penney of Glasgow, obtained on analysis, volatile matter 61·0, pure coke 38·5, ash 0·5=100·0.

Prof. J. C. Booth found, matter vol. at a red heat 59·75, fixed carbon 38·25, ash 0·25, moisture 1·75, and he observes that it has a similar composition to some English bituminous coals.

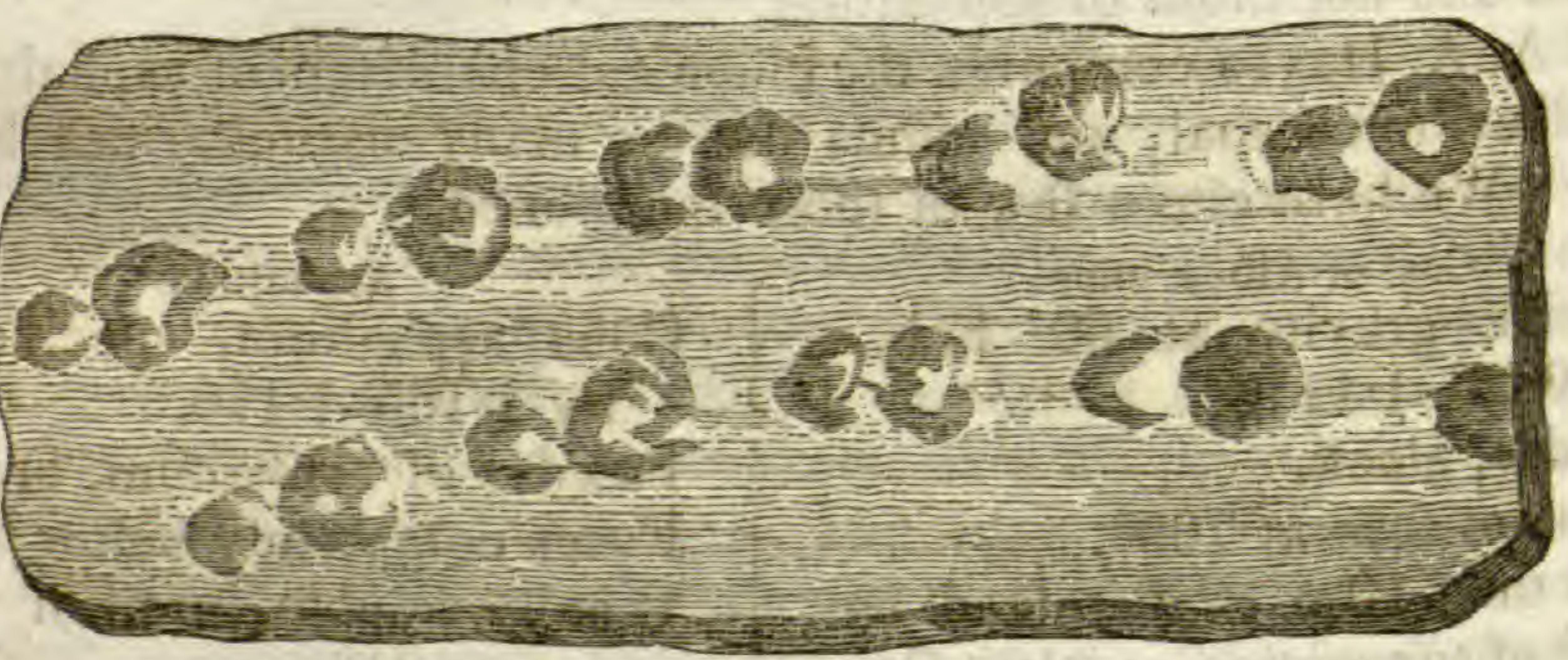
This coal is an exceedingly valuable material for the manufacture of gas for illumination.

9. *Notice of the Remains of Reptiles in the Old Red or Devonian formation of Scotland;* by Capt. L. Brickenden,* F.G.S., and Gideon Algernon Mantell, Esq., LL.D., F.R.S., &c. (An abstract from the Proceedings of the Geological Society of London, December 17th and January 7th.)—Considerable interest has been excited among British geologists by the announcement of the occurrence of the remains of two or more orders of reptiles in the old red sandstone of Scotland, inasmuch as no vestiges of animals of a higher class than fishes had hitherto been observed in the Devonian formation in any part of the world.

The communication by Capt. Brickendon, with descriptions of the fossils by Dr. Mantell, read before the Geological Society of London, gives the following particulars respecting a discovery which is of the highest interest in a palæontological point of view. The old red sandstone strata are largely developed along the coast of Morayshire, and the yellowish crystalline sandstone is extensively quarried in several localities near Elgin, Spynie, &c. These strata, though for years diligently explored by several competent local observers, had yielded but a solitary specimen of organic remains, viz.: the impressions of a series of large scales of a new genus of ganoid fishes, which M. Agassiz named *Stagonolopis Robertsoni*, and has figured in his fishes of the Devonian system.

In the summer of 1850, Capt. Brickendon obtained from a quarry of the yellow sandstone at Cummingston near Elgin a slab bearing the distinct imprints of Chelonian footsteps.† These are thirty-four in

1.



Chelonian footprints in Old Red Sandstone; $\frac{1}{4}$th natural size.

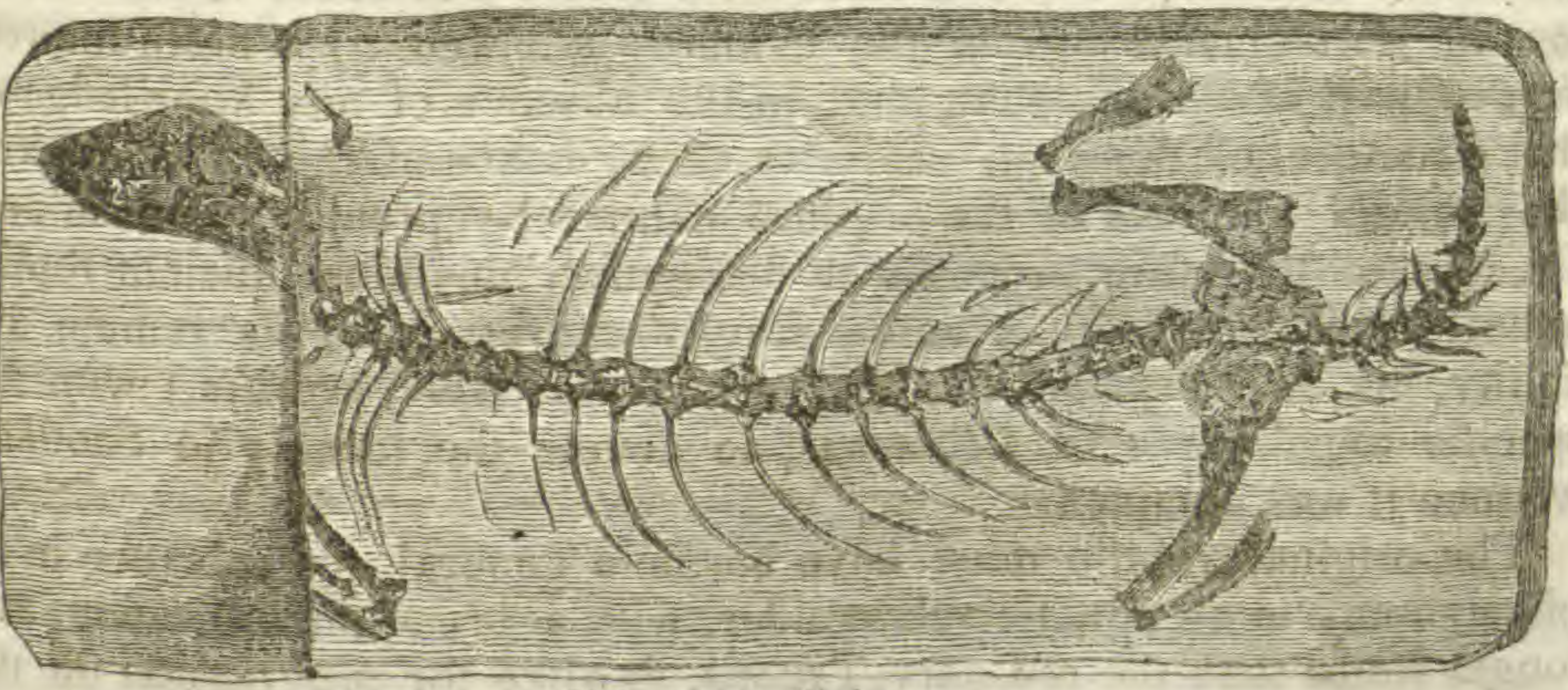
number and extend several feet across the stone. The impressions of the right feet alternate with those of the left, from which they are separated laterally by an interval of three inches, the length of each pace or stride being about four inches. The imprints of the fore and hind feet are nearly in contact; the size of the former in relation to the latter is as three to four; the hinder prints are an inch in diameter. The foot-tracks are obtuse and rounded, and indicate a close connection of the articulations, for no distinct markings of the joints are shown. The discovery of these foot-prints, which in every respect re-

* The name of Capt. Brickendon will be familiar to our readers who have read Dr. Mantell's memoir on the jaw of the Iguanodon, the first specimen of which was found by Capt. B.

† The cuts here given are from the new edition of Lyell's Manual, just published.

semble those from the Triassic and other rocks that are ascribed by palæontologists to turtles or tortoises, is alone an important fact, since it demonstrates the probability, if not certainty, that reptiles existed during the Devonian epoch; hence the attention of those collectors who were aware of the discovery was especially directed to the rocks of Morayshire in the hope of obtaining other vestiges of reptilians, but without success, till in November, 1851, Mr. Patrick Duff of Elgin, the author of an excellent work on the geology of the district, procured from the sandstone at Spynie the extraordinary fossil which forms the principal subject of Dr. Mantell's supplement to Capt. Brickendon's memoir.

2.



Telerpeton Elginense.

This fossil consists of the impression of a great part of the skeleton of a four-footed reptile, about six inches long, in a block of crystalline sandstone which is broken into three pieces. Fortunately the stone is split in a direction parallel with the plane of the spinal column, so that one piece exposes the imprints of the vertebræ and ribs and hinder extremities, and the other the corresponding mould of the upper part. Dr. Mantell by a careful investigation has been enabled to give restored figures of the vertebræ, ribs, femora, etc.; but the original contains no remains of osseous substance, except of the cranium, and that part of the skeleton is crushed and in great measure concealed by the investing stone. The skull appears to have been of an oval form, resembling that of a small lizard or aquatic salamander; but the true outline cannot be determined. There are remains of two or three very minute and smooth conical teeth, but their mode of implantation in the jaws is not obvious. The spinal column from the occiput to the pelvis appears to have consisted of twenty-four vertebræ, each vertebra having a pair of very slender ribs; these processes are short in the anterior and posterior part of the column, and relatively long in the middle dorsal region. The bodies of the vertebræ were apparently doubly concave; their zygapophyses are nearly horizontal; the neural arch forms a slightly elevated dome with an abbreviated spinal process as in the salamanders. There are no remains of the scapular arch, but there are imprints of the left humerus, radius, and ulna; and of the right and left femur, tibia, and fibula. An impression of a subquadrangular form indicates the general shape of the pelvis; there are ten or twelve caudal vertebræ exposed, the remainder of the series being buried in the stone; the length of the tail probably did not exceed an inch and a half. There are no vestiges of the feet exposed, but possibly careful chiselling might reveal the outline of the hind feet, which seem to pass off at right angles from the distal end of the tibia, into the stone.

Dr. Mantell gives minute anatomical details (obtained by a careful inspection of casts made by pressing a soft substance into the sharpest imprints) with the view of directing attention to the most important characters should detached bones or a skeleton be hereafter discovered. Dr. M. concludes that the original was a peculiar type of air-breathing oviparous quadruped, presenting in its osteology certain characters that are found in Lacertians, combined with others that occur in the skeletons of Batrachians. From the evidence afforded by a mere impression of part of the skeleton, and in the absence of any knowledge of the structure of the feet, scapular arch, bones of the cranium, &c., the natural affinities of the original cannot be precisely determined. Dr. Mantell therefore proposes to distinguish this most ancient reptile hitherto discovered, by a name simply expressive of its remote antiquity, viz.: *Telerpeton*, (a τηλε, *procul*, et ερπετον, *reptilis*,) with the specific appellatives of *Elginense*, to denote the locality in Scotland whence it was obtained.

The original reptile must have borne a general resemblance in its physignomy to an aquatic salamander, with a broad dorsal region, and longer limbs than the ordinary Tritons, fit alike for progression on the land or through the water; the tail appears to have been wide. The entire length of the animal did not exceed six or seven inches.

Fossil ova, probably of Batrachians.—In connection with these discoveries Dr. Mantell brought under the consideration of the Society certain fossils which abound in the lower Devonian shales of Forfarshire, and are figured and described by Sir Charles Lyell in his Elements of Geology, as probably the ova of gasteropodous mollusca. These are clusters of small roundish carbonized bodies, which generally occur with remains of aquatic plants. With the exception of the *Cephalaspis* and other ganoid fishes peculiar to the old red, no other fossils but the ova have been found in these beds. The resemblance of these organic remains to the carbonized spawn of recent frogs which Dr. M. had found in the inspissated mud of a dried up pond, led him to suspect they might be the fossil ova of Batrachians; and for reasons detailed at length in the memoir, (and the author's conjecture is corroborated by Mr. Newport the eminent British physiologist whose experiments on the development of the ova in Amphibia have just been rewarded by the medal of the Royal Society,) Dr. M. is of opinion that if the fossil bodies of Forfarshire be of animal origin (as is supposed) they are unquestionably referable to Batrachians allied to the *Ranidæ* or frog family, and not to Gasteropoda; larger ova occur singly or in pairs, and often attached to the foliage (in like manner as the eggs of our Tritons) and these in all probability belong to aquatic salamanders. In confirmation of his conjecture, Dr. M. particularly dwelt on the fact that in the numberless strata of shales, limestones, clays, &c., abounding in shells often in a state of great perfection, with the ligament, epidermis, and even the soft parts preserved in the state of molluskite, no ova had ever been detected; while in the shales of Forfarshire which swarm with these eggs, neither shells, nor even casts of shells, had been discovered. An important geological inference was supported by Dr. Mantell as deducible by these facts. Here we have ova with aquatic plants (apparently fluviatile) and the remains of ganoid fishes which for aught we know to the contrary may like the recent Lepidostei and Palypteri have been inhabitants of rivers; and with no vestiges of shells or other marine organisms; phenomena which lead us to inquire whether the lower Devonian strata of Forfarshire may not be of fluviatile or fluvio-marine origin:—whether, in fact we have not here indications of the intercalation of a series of freshwater deposits in the marine formation called the old red sandstone of Scotland? future observations will determine the solidity of this novel but highly probable suggestion. Should this view be established by future discoveries, Dr. Mantell will have had the singular good fortune to be the first geologist who predicated the presence of freshwater deposits in the palæozoic formations of Scotland, as he established by his own researches the fluviatile character of his native Wealden of the southeast of England.

III. Zoology.

1. *The Relations of Embryology and Spermatology to some of the fundamental doctrines of Physiological Science;* by Dr. W. I. Burnett, of Boston, (From the Proc. of the Amer. Assoc., Albany meeting, 1851, and communicated for this Journal by the author.)—When the influence of the study of organic chemistry and microscopy was beginning to be felt in natural science, the prospect was held out that soon we should understand fully the intimate and primordial relations that exist between the organic and inorganic world.

This was promising too much, and a disappointment has necessarily ensued; still, the quite thorough prosecution of these studies has, I think, produced two distinct results or opinions. With the chemists, the tendency has been to regard the movements of the organic world as simply the results of modified chemical forces. In other words, that matter and chemical power include the phenomena of life. With the microscopists, on the other hand, the tendency has been to consider organic matter as endowed with a power above and beyond these others, and that we are to recognize, in the expressions of life, *vital* as well as chemical forces. I believe this is the tenor of all carefully pursued microscopical studies. With chemists, vitality is always materialized; with microscopists, it exists as an entity above and beyond matter, and may be considered as its thought or idea.

There is a great difficulty in investigating subjects of this kind, because we are in constant want of requisite data from which we can safely draw conclusions. But since my attention has been called to the microscopical study of developing forms, or, in a word, to organic atoms, I have been induced to adopt the opinion that, beyond and isolated from matter, there exist not only what is termed a vital force, but ideas and thoughts.

I propose to illustrate these views by a consideration of some results at which I have arrived in a new and rather peculiar department of microscopy—viz.: spermatology, or that which relates to the intimate nature of the spermatic particles. But that these may be better understood, it is necessary that I should refer for a moment to the present conditions and relations of this branch of science.

In embryological studies, we commence with the simple ovarian cell, or even still further back, with its nucleus. This we trace upward until it has grown to a perfect cell. We then watch the endogenous formation of the cells within it, until it is a great compound cell, which is called the ovum; and then we observe the modification of its contents into a symmetrically-shaped body, which is the new being. Now, throughout the animal kingdom, not only has this primitive ovarian cell the same material aspect, but the same is true of the great compound cell or ovum. This, then, is the fundamental point in all development—and from the most careful examination with the highest and best microscopical instruments, we are unable to perceive why one cell should give rise to a spider, while another, appearing exactly like it, should give rise to a bird. We can reason only from what we know, and if in studying the ultimate atoms of two different portions of matter, we can detect no difference with our present instruments, we certainly have a right to affirm that these portions of matter are identical in physical character. We have a right to infer, also, that that power which prompts each cell to its ulterior condition, viz.: the production of a spider or a bird, has, in the cell, no material expression by which it can be determined, but that it resides as a simple, pure force or individual entity.

Some may call it a dynamic power inherent in the cell, but this is only expressing the same in different terms. We have, then, in a single cell, the complete idea of a bird existing not as a material condition, but as a pure individuality; which last is shown by the fact that the idea is not that of simply *a* bird, but *one of* distinct characters, which here exist *in* thought or type so minutely as to comprise even the color of the bill and length of the feathers.

This view is well supported by all facts of hybridization; for when allied species unite, and there is in the offspring a union of the characteristics of each, this last could have occurred only at the time of fecundation, when the ovum was merely a compound cell, and when it must have possessed all the specific character of the female. In this relation I cannot do better than to quote the words of the profound Müller. He says: "The simple embryo, which consists of a granular shapeless substance, is to be regarded as the potential whole of the future animal, supplied with the essential and specific force of the future animal itself." It may be urged that this idea is quite indistinct, and that we are deviating from the true method of physical investigation; by affirming that the forces of a bird, for instance, exist as such before the material organs by which they are to be expressed have been formed; but this objection is not true or valid, not only because it is based on a mere opinion of the nature of organic matter, but also because it is contrary to many facts; for we do have *attempts* at the expression of individual forces long before the organs by which they ultimately find their complete exhibition are developed, or even when they are never developed. Let me therefore add that if careful embryological studies teach anything in this connection, it is that each healthy ovarian cell contains the potential whole of an individual like the parent, and which is constantly seeking its complete development to be attained only by the co-operation of a corresponding element of the opposite sex, and that the type of form ultimately expressed, being the outward exhibition of inward forces, cannot long suffer deviation without destruction, and is fully as permanent as the individual itself.

If we are not allowed these forces in organic forms, we certainly never can rise above the immaterial forms; and there would appear to be no reason why the ovarian cell of a bird should not produce a mammal as well as a bird. But these relations are not equally clearly understood by all; and some whose attainments should have led them to think differently, have so failed in their appreciation of them that they have regarded the ovum as simply an organic molecule, thus putting an end to all dispute in their own minds, as to spontaneous generation and epigenesis.

I have thought, if anything was wanting in embryology to render such views complete, the complement could be fully found in its counterpart science, spermatology, and I have therefore taken it up in that connection.

What embryology is to the female, that spermatology is to the male. In a histological point of view, the process is the same in each sex. In the one, you have a simple cell passing on in development to a new being; in the other, you have a simple cell passing on to the development of an organic vitalizing particle, which is the prototype of that being. There is, however, this difference, which should be remembered—it is, that in embryology, the new individual form is the result of the co-operation of the two sexes; while in spermatology it is the result of one. Therefore, our philosophical studies in the latter begin for the most part where in the former they have ended; for the spermatic particle is the material expression of the male, both generally and specially. It is, in fact, the male embryo. The course of study by which this important truth has been ascertained, I have treated of in another place.

We here begin with the simple testicular cell, the growth of which we watch until it has become the great compound mass, the parent sperm-cell, in which, by a modification of its contents, are developed the spermatic particles. These organic particles are the true and only fertilizing agents in the process of fecundation, in which experience has shown that they do not merely fertilize—that is, light up a pile before already to burn—but they co-operate and furnish conditions essential to the perfect result. We know very well, that, in the higher animals, where often there is a dissimilarity of form and external appearance of the two sexes, the offspring not unfrequently have all the characteristics of the male, even down to minute points.

In our own species, we are daily observing how correctly and faithfully the child often inherits, not only the physical, but also the peculiar mental features of its father; and too often, too, do we see in the same inheritance a variety of disease. Now, experiment has shown that, in this process, a single spermatic particle only is required, and that there is no incorporation of its substance with the ovum, but that the whole is accomplished by mere contact with the periphery of the ovum. We have, then, in a word, the organic particle of a male, microscopically minute, which, by mere contact, and without any material loss, transmits to the ovum not only the potential whole of the male generally, but minute mental and physical characteristics. It must be, therefore, that in a minute particle of matter there are hidden often not only the silent thoughts or prototypes of poetry and art, but also of peculiar love and affection.

It cannot be otherwise, and is no more difficult to be comprehended, nor is the idea less beautiful in suggestion, than that these same *thoughts*, when matured in after life, with daily expression, should occupy the strange relation which they do with the material substance of the brain.

It is argued that the idea of *transmission* of force is quite unphysical. Because says the chemists, that only which is substantial can be communicated. But this I consider simply reasoning on the ground that a condition in nature is impossible because it eludes our means of study and observation. But if we are led to take views like these, we must not at the same time suppose that all spermatic particles are, like ova, identical in physical appearance; for the spermatic particle is not the analogue of the ovum, but of the new being; and, as in the latter, so in the former we find well-marked differences of type. Still, the physical characteristics of this particle are not always expressive in any way of the individual of which it is the prototype, and both the similarities and dissimilarities afford a fine argument on the point we are now discussing. For instance, I can show a spermatic particle of a duck, which, as to external appearance, as well as by microscopical measurement as to length, breadth and thickness, cannot be distinguished in any way from another of a reptile. Yet in the one is embodied the idea of a bird, even to the color of its plumage; while in the other is embodied the thought of a reptile.

But there is another point from which I wish to view this subject, and which takes us still further back in histology. I refer to the type of the spermatic particle itself. In any animal, there is but one form of this minute particle, and from it there is never any variation, any more than there is in the elimination of the embryo from the female; and exactly as there resides in the ovum the thought or idea of a future embryo of a certain shape, so it may be considered there exists in the sperm cell the thought or idea of a spermatic particle of a peculiar form. This may be safely inferred from the uniformity of results with which we meet; but in the course of my studies in this direction, I have met with phenomena which illustrate this point in a striking and beautiful manner, and at the same time exemplify to us how wondrous and how certain is this type-power in the ultimate attainment of its object.

With one or two preliminary remarks, I will show what I here mean. In the development of a spermatic particle, you have, as I have before said, the parent sperm cell, which is a large cell filled with small ones, each of which is nucleated. The direct formation of the spermatic particles here begins to take place, and it occurs in two general modes. The first is called the special cell; the second the fascicular mode of development. But in some of the Rodentia, I have observed, even in the same animals, *both* modes of development. In fact, two parent sperm-cells, side by side—in one of which the spermatic particles are eliminated by the fascicular, while in the other by the special-cell mode. The results were exactly the same, and the particles of each could not be distinguished from each other. We have here, then, a single identical result from two dissimilar processes. This fact stands for a great deal; for it would appear that whether the development takes the right or the left hand road, the type-power brings out always the same result. It is destined to get its expression some way, and certainly appears to argue that there are dynamics above and beyond material forms.

When an artist portrays in sculpture the outward forms of the beautiful human face, we can have no doubt that the image of the same lived in his imagination before the material work was commenced. But when the same artist portrays in painting also the same beautiful face, with exactly the same lineaments, this affords an additional evidence that the conception was pure and distinct, and lived as such in his mind; and it mattered but little whether it took this or that outward visible form, for the expression of the creative thought would always be the same.

Exactly so it is with spermatic and embryonic typical forms. The idea or thought behind each proves its individuality by the uniformity of its expression. It matters but little or nothing whether gained in this or that manner.

In conclusion, let me say that I consider a thorough appreciation of these doctrines of what may be termed higher dynamics quite essential to the progress of physiological science; and I cannot see why men should retard it by a series of detailed explanations which really obscure the matter. Why not recur at once, for instance, to vital force, for the explanation of certain phenomena, and then we shall have a point of departure, the determination of the laws of this *vital force* remaining for our future study.

Liebig says: "As soon as physiologists meet with the mysterious vital force in any phenomenon, they renounce their senses and faculties; the eye, the understanding, the judgment, the reflecting faculties, all are paralyzed, as soon as a phenomenon is declared incomprehensible." I do not consider this true, or even if it is partially so, it applies to the chemist as well as to the physiologist. It is useless to cavil about these matters. We must have terms to express phenomena. In the natural world, one thing appears almost as mysterious as another. Even if we do reduce everything to mechanics and chemical action, is the matter then made more clear? Do we know anything about the fundamental principles of mechanics or chemistry? or is a *vital force* more mysterious than is *motion* with the one, or *affinity* with the other? Is it more comprehensible that an elective affinity should exist in inorganic particles than that animal types should exist in organic ones? Of all these matters, we know nothing except from their objective phenomena, and we cannot indeed do less than to show a consistency in their recognition.

2. *An Improved Method of killing and preparing Lepidopterous Insects for Cabinet Specimens;* by J. P. Kirtland, M.D.—In making collections of Lepidoptera, the means usually employed for destroying life—such as compressing the thorax, puncturing the thorax with a needle or pin wet with oxalic acid, smothering with ether, chloroform, or fumes of sulphur, are objectionable, on account of their impairing the beauty if not actually mutilating the specimens. A more successful method is to puncture the thorax once or twice with a needle wet with a strong solution of cyanid of potassa, holding the specimen between the thumb and forefinger so as to keep the wings from fluttering. This solution should be kept in a well stoppered phial; and the needles (of different sizes) may be mounted in light handles. To prevent oily exudations and preserve the colors of the body, the contents of the abdomen (if the animal be large, or even of medium size) should be removed and the cavity filled with cotton. For this purpose a common dissecting case containing a delicate pair of sharp-pointed scissors, scalpels, sewing needles, &c., will furnish all the necessary tools except a steel fork. This fork may be expeditiously formed from a small sized netting-needle, by cutting off with a file the blunt end near its extremity, so that the two sides of the eye may form the tines of the fork, each of which should be filed down to the required form and size. The needle may then be shortened at the other end and set in a handle when it is ready for use. This instrument is very useful in all kinds of Taxerdermy.

The specimen to be prepared should be firmly secured on its back by inserting a pin through its thorax into a pine-table. An incision should then be made the whole length of the abdomen with a pair of sharp-pointed scissors. The sides of the incision may be kept separated by inserting between them a pair of elastic dissecting forceps and permitting the blades to expand apart. The viscera can then be scooped out by aid of the hasp of an ivory-handled scalpel gently carried from the thorax, backwards—taking care not to stain, mutilate or discolor the integuments. Pulverized arsenic (arsenious acid) should then be applied liberally to the internal surfaces. The handle of a scalpel also answers the purpose of a spatula for this operation.

To restore the natural form to the body, roll a pledget of cotton into a conical form, and of suitable size, on the end of the fork-tines, and insert it into the body of the insect, the apex of the cone towards the vent. The elastic forceps will still be of use in keeping the incision open while applying the arsenic and inserting the cotton-body. Should not all the parts be filled out to their proper size, small portions of cotton may be carefully crowded in, on the fork, till the work is effectually accomplished.

A little experience in forming the body, on the fork, and in moulding it to its proper size and form by rotating the handle of the instrument in the right hand and compressing the cotton with the fingers of the left hand, will greatly aid in perfecting the operation.

The sides of the incision may now be brought exactly together, so as to show no deformity. Arm each end of a piece of fine thread, a foot in length with a needle, and in sewing, carry the needles from within the incision, out; drawing both sides at the same time.

The specimen should then be mounted in a natural position, usually with the wings extended. For this purpose, provide a strip of pine board or other soft wood, five or six inches wide, and one inch thick, grooved its whole length in the middle of one of its flat surfaces, the groove to be $\frac{1}{2}$ an inch deep and from $\frac{1}{4}$ to $\frac{1}{2}$ an inch in width, according to the size of the insect. It is well to have on hand a supply of different widths.

The pin should be withdrawn and put in from above, fixing the body in the groove of the board, and its point in the wood; the wings may then be expanded to their proper position and fastened by a few small pins. Brackets of card-paper may occasionally be employed, but they are liable to compress and disfigure the delicate pile on the wings.

It is perhaps proper to add that the utmost care is necessary in employing a poison as deadly and virulent as cyanid of potassa. Other classes of insects may be killed with it, but its impressions are more instantaneous on Lepidoptera than on any other. Is it hence to be inferred that their nervous systems are of higher order and that they therefore occupy a higher scale in the order of creation than other classes of insects? This we believe would be in accordance with the views of Prof. Agassiz.

3. *On the Perforation of Rocks by Pholades;* by M. F. Caillaud, (Comptes Rendus, Nov. 24, 1851, 572.)—M. F. Caillaud sustains the view that the rocks occupied by the Pholades is mechanically excavated by the animal, by means of its shell. He observes that in less than an hour and a half, he dug out with one of the shells a hole eighteen millimeters deep in limestone; and shows by the circular scratches in some of the holes, that the animal actually uses a rotary movement in the excavation. Moreover, they work out holes not only in limestone, but also in gneiss, mica slate and other rocks, many specimens of which he had collected; and he denies that an acidulated secretion, (to which such perforations are usually attributed,) can perforate both limestones and gneiss or mica schist.

IV. Astronomy.

1. *Supposed new Planet.*—On the 8th December, 1851, Prof. De Gasparis in Naples, discovered near Saturn a very faint star, which he considered a new planet; but no intelligence of the confirmation of this discovery has yet reached us.

2. *Symbolical Notation of the Asteroidal Planets*, (Gould's Astron. Jour., No. 34.)—On account of the inconvenience resulting from the present arbitrary symbols for the large family of small planets between Mars and Jupiter, it has been agreed upon by several astronomers in Germany, France, England and America, to propose for adoption a more simple system for this group, viz.: a circle containing the number of the planet in the order of its discovery. It is to be presumed that this plan will be generally adopted. The following table gives the names of such of these planets as have hitherto been observed, with the time of their discovery, and the name of the discoverer.

Names.		Date.		Discoverer.
1. Ceres,	1801,	January 1,	.	Piazzi.
2. Pallas,	1802,	March 28,	.	Olbers.
3. Juno,	1804,	September 1,	.	Harding.
4. Vesta,	1807,	March 29,	.	Olbers.
5. Astræa,	1845,	December 8,	.	Hencke.
6. Hebe,	1847,	July 1,	.	Hencke.
7. Iris,	"	August 13,	.	Hind.
8. Flora,	"	October 18,	.	Hind.
9. Metis,	1848,	April 25,	.	Graham.
10. Hygeia,	1849,	April 12,	.	Gasparis.
11. Parthenope,	1850,	May 13,	.	Gasparis.
12. Clio,	"	September 13,	.	Hind.
13. Egeria,	"	November 2,	.	Gasparis.
14. Irene,	1851,	May 20,	.	Hind.
15. Eunomia,	"	July 29,	.	Gasparis.

V. Miscellaneous Intelligence.

1. *Meteorological Instruments.*—The barometers and thermometers used under the direction of the Smithsonian Institution, and in the various academies of Massachusetts and New York, where they have recently been placed by Prof. Guyot, are made by James Green, No. 422 Broadway, New York. We copy the following from the recent Report of the Institution, (1851) p. 17.—The barometer has a glass cistern with an adjustable bottom enclosed in a brass cylinder. The barometer tube is also enclosed in a brass cylinder, which carries the vernier. The whole is suspended freely, from a ring at the top, so as to adjust itself to the vertical position. the bulb of the attached thermometer is enclosed in a brass envelop communicating with the interior of the brass tube, so as to be in the same condition with the mercury, and to indicate truly its temperature. Each instrument made according to this pattern, is numbered and accurately compared with a standard. In the comparisons made by Professor Guyot, a standard Fortin barometer, by Ernst of Paris, was employed; also a standard English barometer, by Newman, of London, belonging to the Institution. These instruments, for greater certainty, have been compared with the standard of the Cambridge Observatory, and of Columbia College, both by Newman; also with the standard of the Observatory of Toronto, Upper Canada.

The results of these examinations prove the barometers made by Mr. Green, according to the plan adopted by the Smithsonian Institution, to be trustworthy instruments.

The thermometers are by the same maker, and those intended for the State of New York, were compared with a standard by Bunsen of Paris, and with another by Troughton & Simms of London. Those found to differ more than a given quantity from the standards were rejected.

The instruments for detecting the variation of the hygrometrical condition of the atmosphere, consist of two thermometers, of the same dimensions, accurately graduated. The bulb of one of these is enveloped in a covering of muslin and moistened with water, and that of the other is naked.

The rain and snow gauges, and also the wind vanes, are made under the direction of the Institution, by Messrs. Pike & Son, 166 Broadway, New York. The rain gauge is an inverted cone of sheet zinc, of which the area of the base is exactly one hundred square inches. This cone or funnel terminates in a tube which carries the water into a receiving vessel. The water which has fallen is measured by pouring it from the gauge into a cylinder, so graduated as to indicate hundredths of inches. A smaller cylinder is also provided, which gives thousandths of inches, and may serve, in cases of accident, as a substitute for the larger cylinder. The rain gauge is placed in a cask sunk in the earth, with its mouth near the level of the ground.

The snow gauge is a cylinder of zinc of the same diameter as the mouth of the rain gauge. The measurement is made by pressing its mouth downwards to the bottom of the snow, where it has fallen on a level surface, then carefully inverting it, retaining the snow, by passing under it a thin plate of metal. The snow is afterwards melted, and the water produced is measured in one of the graduated glass cylinders of the rain gauge.

The wind vane is a thin sheet of metal, (it might be of wood,) about three feet long, carefully balanced by a ball of lead, and attached on the top of a long wooden rod, which descends along the wall of the building to the sill of the window of the observer. It terminates in the centre of a fixed dial plate, and indicates in its movements the direction of the wind by a pointer attached to the rod.

The observer is by this arrangement enabled to determine the course of the wind, by looking down on the dial plate, through the glass of the window, without exposing himself to the storm.

Besides the full sets of instruments furnished by the State of New York, from the appropriation of the Regents of the University, the Smithsonian Institution has furnished a number of sets, to important stations, and in order that they might be more widely disseminated, we have directed Mr. Green to dispose of sets, to individuals, at a reduced price, on condition that they will give us copies of the results of their observations; the remainder of their cost being paid by the Institution. A number of persons have availed themselves of this privilege.

To accompany the instruments, and for the use of those who take part in the Smithsonian system of meteorological observations, a series of minute directions, prepared by Professor Guyot, has been printed by the Institution. It occupies forty octavo pages, with wood-cut representations of the instruments, and is accompanied by two lithographic engravings, to illustrate the different forms of clouds, and to facilitate their notations in the journals, in accordance with the nomenclature adopted by meteorologists. A set of tables has also been furnished for correcting the barometrical observations, on account of variation of temperature. A set of hygrometrical tables, to be used with the wet and dry bulb thermometers, and a set, for the calculation of heights by the barometer, will be prepared.

2. *Notice of Meteoric Iron in the Mexican Province of Sonora;* by John L. Le Conte, M.D.—In February, 1851, while at Tucsan in

Sonora, I saw two large masses of iron, evidently meteoric, which were used as anvils by the two blacksmiths of that town. They were irregular in form, and although imbedded in the ground to make them steady enough for use, they were about three feet high. I endeavored to have some pieces cut off, and although a high price was offered, the characteristic Mexican indolence could not be overcome. The only answer I could obtain, was the metal was "muy duro."

These pieces were brought from a valley in a small mountain chain, about forty miles southeast of Tucsan, east of the road leading to Tuvaca. In this valley, fragments similar to those seen, and of various sizes were said to be abundant. From the occurrence of this metal, the valley was called "Cañada de Hierro," or iron valley. Silver mines of great richness are very numerous in that vicinity: the metal occurs as sulphuret, with galena and blende, and also in the native form.

3. *On the Improvements by Mr. Chas. A. Spencer in Microscopic Object-glasses*, (from a letter from Mr. Chas. A. Spencer, addressed to Prof. Horsford and Dr. Burnett, published in the Boston Traveller.)—The following letter from Mr. Chas. A. Spencer, the celebrated maker of Microscopes at Canastota, N. Y., was received by Prof. Horsford and Dr. Burnett, as an answer to some definite inquiries made concerning the method by which his extraordinary results have been obtained. It was not intended for publication, but this use is made of it on account of its scientific importance. It contains a clear and concise statement of the difficulties and perplexities that attended those wonderful improvements in the manufacture of lenses, recently made by him; and, on account of which, it will be remembered that the Committee appointed at the Albany meeting of the American Association for the Advancement of Science, held in August last, decided that his glasses are quite superior to any now made in the world. On this account the letter will be read with interest by all, and especially by those who are versed in the optics of Microscopy. H. & B.

* * * "If I properly understand your request, it was that I should give you a statement of the peculiarities of construction, &c. which distinguish my microscopic objectives from those heretofore made.

To do this with sufficient clearness, it will be necessary for me to explain briefly the defects of the best objectives at the time I commenced my investigations. At that time the largest angle of aperture obtained by any optician, did not exceed 75° with even the highest powers. The objectives of Pritchard, Chevalier Oberhauser, Plœssel and Schieke, rarely reach this number of degrees, even at the present time. Owing to the character of the materials at the command of the working opticians, in connection with the fact, that all the existing works upon science were silent in reference to any formula or laws of combination, the construction of objectives had become nearly stationary as regarded their most essential character—*that of angle of aperture.*

The method then employed by the best artists was one entirely practical; and consisted merely in combining three double achromatics, (separately corrected for figure and color, or nearly so,) into one objective; and the differences which were to be found in the objectives of different artists, consisted mainly in the focal lengths employed to make up a given objective, most artists combining three objectives of the same focal lengths and aperture. It is obvious that by such methods only fortuitous results could be obtained, no data existing by which new combinations could be calculated without vast labor, and the artist himself entertaining no hope that his materials were capable of yielding higher results.

The reason of this conclusion may be briefly stated. At an early stage of the improvements of the achromatic microscope, it was assumed as essential, that the different combinations should be so calculated as to permit the inner surfaces of the crown and flint lenses to be cemented, in order to prevent alike the loss of light and the indistinctness which would arise from so many otherwise reflecting surfaces. This practical rule being assumed, the construction of an achromatic object-glass, of the simplest form, became a determined problem, or nearly so; and the artist was confined within very narrow limits as to available radii and apertures with the best material he could command,—the crown, and dense flint glass of Guinaud.

The limit to the increase of aperture of an object-glass of given focal length, was soon found in the inequality of correction for sphericity; a marginal over-correction, and a central under-correction for figure, being the result of all attempts beyond this limit.

Such was the condition of optical knowledge applicable to the microscope, when the paper of Lister in the Phil. Trans. gave a new impulse to improvement, by making known some laws of combination before unnoticed, and calling attention to some characters of single achromatics, which might be made available in the formation of unusual combinations; which paper, up to the present time, is the only one that has appeared on this intricate subject. Improvements followed rapidly upon the appearance of this essay; and soon again reached a limit, beyond which the artist had no expectation of success.

So late as the year 1844, Mr. Ross, then, as now, the first of European artists, in announcing that, with his $\frac{1}{12}$th objective, he had reached the angle of aperature of 135°, declared, that a pencil of that angle, was 'the largest that could be passed through a microscope object-glass.'

It was under such circumstances of embarrassment, or rather of apparent hopelessness, that I continued the series of investigations, before began, which had for its object the improvement of the microscopic object-glass, in the very particular which was declared impossible by Mr. Ross.

Becoming satisfied at a very early period of my labors, that no real success could follow upon merely practical investigations; and feeling assured also that opticians had entirely neglected an essential element of their education,—that of an earnest study of the optical and physical characteristics of the materials upon which their skill was exercised, I undertook a series of experimental investigations in the manufacture of glass for optical purposes, with a view of supplying this deficiency in my knowledge, and of definitely solving the question of maximum angle of aperture of objectives.

Many new, unexpected, and valuable results were obtained, in reference to both the optical and physical characters of this interesting material. During the long course of labor and study, which these investigations rendered necessary, new laws of combination appeared, involving intricate theoretical investigations, and giving promise of results before unattained, not only with the new materials, but (from an increased knowledge of its optical characters,) with those also, in common use among artists.

To fulfill the conditions which were imposed by these new laws, in connection with those previously announced by Lister, it became a practical question how far skill in manipulation, to give the requisite curves, and mechanical construction to secure most, if not all, the practical conveniences required by the observer, could be made available.

Two and a half years since, I satisfied myself and others, that the limit assigned by the high authority of Mr. Ross, to the angle of aperture, was erroneous, and that this limit had no existence short of 180°. The question whether theory placed bounds to human skill, being thus satisfactorily determined, a question no less serious arose as to the means to be employed to make the largest attainable angle of aperture available, without sacrificing those conveniences which alone would render such an angle useful. The difficulty of this mixed theoretical and practical question will be understood from the fact that, more than two years since, angles of aperture of 170° were obtained by me, but the sacrifice of the working focus seemed then an insuperable bar to the employment of such objectives, as ordinary working and available powers. Every increase of their capacity in one direction, seemed made at the inevitable expense of some equally necessary capacity in another.

Nearly two years of unremitting thought have been given to the solution of this question alone. Six months since, a careful re-examination of the whole subject enabled me to surmount this last obstacle in the way of improvement,—leaving the field clear to those recondite investigations, which alone are wanting to place the seal upon the microscope as a perfect instrument.

Such, then, is a brief sketch of my labors in connection with this subject; and you will readily see, that to no one particular combination or discovery, has any success of mine been especially owing;—but to a lengthened study of the characters of the materials themselves,—the discovery of new qualities and capacities in glass, to new laws of combination, and to the union of these various acquisitions, so as to make practically available, those excellencies which were indicated by theory.

4. *On copying Copper Plate Engravings on Stone*, (from a letter from Lieut. E. B. Hunt, to J. D. Dana, dated New York, Jan. 17, 1852.)—I enclose some specimens of lithographic transfer printing of the plates to be in the forthcoming Coast Survey Report. I assume that you are interested in any thing of this kind, and the specimens we are now obtaining show so great an advance that it is worth reporting.

The process is briefly as follows. A copper plate being duly engraved, it is inked and an impression is taken on transfer paper. A good paper, which wetting does not expand, is needed, and a fatty coating is used in the process. The transfer paper impression is laid on the smooth stone and run through a press. It is then wetted, heated and stripped off from the stone leaving the ink and fat on its face. The heated fat is softly brushed away leaving only the ink lines. From this reversed impression on the stone, the printing is performed just as in ordinary lithography. A good transfer prints from three to five thousand copies. Thus prints from a single copper plate can be indefinitely multiplied, the printing being moreover much cheaper than copper plate. The enclosed specimens which are only fair ones, show the applicability of this process to very fine topography and other fine engraving.*

5. *Note to Dr. Kirtland's paper, page* 215.—A lower degree of cold has recently been experienced throughout the west than occurred during the ten years preceding.

On the 16th and 17th of December, ult., the temperature was as follows, viz.:

	Dec. 16.	Dec. 17.
At Cleveland,	–6	–5
Painesville,	–8	—
Sandusky,	–8	—
Elyria,	–12	—
Ravenna,	–12	—
Akron,	–14	–17
Zanesville,	–9	—
Columbus,	–5	—
Marietta,	–3	–2
Cincinnati,	–4	–3

The schedule places the extreme of cold six degrees lower on the margin of the lake, than was stated in the foregoing article; yet the modifying influence of this body of water were equally apparent on that occasion. It will be observed that at Cincinnati and Marietta, lying at the extreme southern part of the state, with the advantage of high ranges of hills to screen them from the north, and a great amount of local heat generated from animal life and artificial fires, the mercury fell as low within two or three degrees, as at this point where nothing intervenes, except the lake, to arrest the winds from the north pole, or mitigate the cold.

At Painesville and Sandusky a little more remote from its influence, the mercury fell to 8° below zero; while in the interior of the state, it sank several degrees lower. During those two days the general cold seemed to contend for predominance with the warmth of the lake. Even at the low temperature which prevailed, warm emanations were constantly arising from the water and exhibited a beautiful phenomenon when viewed from the perpendicular bank of the lake, which rises 80 feet above its level, at this point. The warm vapors ascended several feet into the air, then condensed, congealed and fell back again in such rapid succession as to cut off from view the water, and to give to the unlimited expanse of the lake, the appearance of an immense cauldron, waiving or boiling like plaster of Paris parting with its water of crystallization at a high temperature.

* The specimens sent us fully sustain Lieut. Hunt's remark. His letter continues, "The establishments in New York which do *good* transfer work, are J. Ackerman's, 379 Broadway, and D. McLellan, Spruce street. Both are employed on the Coast Survey Report."

It was a cloud of these snowy spicula, thus formed, which enveloped the steamer Mayflower, and resulted in her running ashore. Passengers on board of her, though surrounded with falling snow, could occasionally discern the sun and clear sky overhead. The occurrence of this extreme cold at a time when the lake contained no ice, and the water was comparatively warm, was extraordinary. Our coldest weather usually happens in February, when the lake is extensively covered with ice. The northern birds seemed instinctively to foresee or anticipate the approach of a severe winter, for the white Arctic owl, pine grosbeak, red poll, and white snow birds appeared in the month of October; an occurrence never before observed.

6. *On the Cold of the month of Jauuary at Eutaw, Alabama*, Lat. 32° 46′ N. Long. 11° 3′ W. of Washington; *and on the Aurora of September* 29th, (from a letter from Mr. A. Winchell, dated Jan. 30.)—The cold of the present winter has been remarkable, and so far as I can learn, unprecedented. My thermometers for four days beginning with the 19th Jan., stood as follows :—

Day.	Sunrise.	9 A. M.	3 P. M.	9 P. M.	Mean.
19,	5	6	9	6	6·50
20,	2	8	21	19	12·50
21,	15	22	34	31	25·50
22,	18	20	28	21	21·75

I am unable to find any record of observations made in this latitude or lower, indicating an equal degree of cold. On the morning of the 18th December the thermometer stood at 9°. These are the extremes; but in general the winter has been characterized by almost uniform and severe cold.

While writing, I will add that the *aurora borealis* of the 29th September, was witnessed here as a very extraordinary and interesting phenomenon. I extract from a record made at the time: 'About 7 P. M., columns of blood-red light were seen streaming up in the northern and northeastern horizon. These were constantly changing their dimensions and forms, and new ones were continually appearing and disappearing. The longest streaks I estimated to extend to about 55° altitude. They were at this time all illuminated completely to the horizon and of a uniform blood-red color. At 8 P. M., there appeared in the north a well-defined arch of bright yellowish light. This was surmounted by normals tinged with evanescent hues of purple, green and red. The display lasted till near midnight.'

7. *Indian Hail-storms.*—Lieut. Col. Sykes, at the meeting of the British Association at Edinburgh (Rep. for 1850, p. 43) stated accounts of numerous hail-storms in India, obtained through the researches of Dr. Buist, LL.D., of Bombay. Dr. Buist says there is no account of the occurrence of hail within 1000 feet of the level of the sea south of latitude 20°, though just to the north of this hail-storms are very abundant, and they occur very frequently within the tropics at altitudes of 1700 feet and upwards. From the list, the hail-storms appear to have occurred 21 times in the month of April, 13 in March, 8 in February, 3 in January, 6 in May, 3 in June, 2 in September, 2 in November, and 2 in December. A few instances will suffice to show their character, and these are given from European testimony. On the 10th of

April, 1822, at Bangalore, a hail-storm killed many cattle, the hailstones being represented by the natives as large as pumpkins. *Three days after the storm* the gentleman who gives an account of it, says, "I went to the spot and found the carcases of twenty-seven bullocks lacerated by hailstones; also dead birds. In a tank 300 yards in circumference, half of the surface was covered with floating masses of hailstones which had been carried down the ravines two days before; some of the masses were five and a half inches in thickness; the hailstones were angular and oval, and some measured three inches in diameter."*

At Kamptee, on the 3d of June, 1823, an officer writes, "the hailstones without exaggeration were as large as pullets' eggs."

At Bopalpoor, on the 9th of February, 1825, an officer writes, "the hailstones were the largest and most extraordinary ever seen, some of them being as large and as heavy as goose-eggs, which they resembled."

At Serampoor in Bengal, on the 30th of March, 1827, the European writer says, "each of the hailstones was equal to the size of a goose's egg."

At Kotah, on the 5th of March, 1827, the hailstones were as large as a man's fist, and the next day remained unmelted of the size of pigeons' eggs. Men, animals and birds were killed; in the village of Nauda alone, six persons were killed and seven others dangerously bruised.

At Calcutta, on the 20th of April, 1829, the editor of the Bengal Chronicle says, "one of the hailstones brought to us was larger than a duck's egg;" many of them were angular fragments of ice, and several natives were killed.

At Serampore the hailstones were as large as hens' eggs, and consisted of coats like an onion; the nucleus was whiter than the exterior.

At Sylhet, on the 19th of February, 1830, the hailstones were of the size of the largest potatoes.† Sheep and goats were killed. At Jubbalpoor, on the 9th of April, 1831, the hailstones were of the size of guinea fowls' eggs. On the 10th of April, 1831, at Kamptee, some of the hailstones measured from ten to twelve inches in circumference; few or none were smaller than a hen's egg; five persons were killed in the neighborhood. At Alhahabad, on the 5th of May, 1833, a hailstone weighed 6¾ ounces troy, and measured ten inches in circumference. At Chunar, on the same day, the gentleman writes, "blocks of ice fell; I am really speaking within bounds when I say a goose's egg was a trifle compared to some of the stones that fell; one measured 11½ inches in circumference." "I am informed," he adds, "one hailstone in the bazaar weighed *two pounds*." On the 16th of March, 1834, at Raneegunge, a gentleman traveling in a palkee, writes, "my palkee top yesterday was broke through in three places by hailstones, and one of my bearers knocked down by them." At Pubna, on the 12th of April, 1834, one of the hailstones measured a foot in circumference, and another weighed eleven ounces. At Benares, in February, 1836, some of the masses of ice weighed two pounds. At Secunderbad, on the 30th of March, 1837, some of the hailstones were two

* This was on the third day after the fall, in the scorching month of April.

† Potatoes in general are not much larger than hen's eggs in India.

inches in diameter. At Dum Dum, the artillery cantonment in Bengal, on the 8th of April, 1838, two hailstones were picked up which measured sixteen inches in circumference and more than five inches in diameter. At Jaulna, on the 14th of January, 1849, the hailstones were as large as billiard-balls. On the 5th of February, 1850, at Gwalior, pieces of ice fell nearly two pounds weight, and animals and some men were killed. At Condwiel, near Sattarah, on the 7th of April, 1850, some hailstones were as large as cocoa-nuts; the writer says, "I am within the mark when I say they were as large as cocoa-nuts."

8. *Meteorology of St. Bernard and Geneva.*—Prof. E. PLANTAMOUR, in the Bibliothèque Universelle, Nov., 1851, xviii, 177, has published an interesting paper on the climate of St. Bernard and Geneva, for the year 1850. The following table, made up from the several tables in the paper, present some of the results.

	Temperature.		Barometer.		Rain & Snow.		Intens. of winds.		Clearness of sky.			
	G. Cent.	St. B.	G. mm.	St. B. mm.	G. mm.	St. B. mm.	G. NE : SW	St. B. NE : SW	G. mean	St. B. mean.	G. days clear.	St. B.
Jan.	− 2·52°	−11·00	726·18	558·46	41·5	146·6	1·05 : 1	2·20 : 1	0·89	0·55	1	9
Feb.	+ 4·00	− 5·58	731·20	565·35	23·5	131·8	0·50	25·29	0·53	0·42	8	14
Mar.	+ 2·40	− 8·22	728·93	562·34	4·7	38·5	2·14	7·36	0·33	0·33	16	17
Apr.	+ 8·09	− 3·70	722·07	559·88	128·8	133·3	1·25	2·30	0·76	0·78	1	0
May	+10·88	− 1·56	723·72	561·77	112·9	124·2	2·00	0·83	0·61	0·72	2	5
June	+16·76	+ 4·78	727·38	567·80	66·4	66·7	2·55	1·55	0·58	0·63	4	5
July	+17·68	+ 5·42	727·11	567·76	36·0	36·2	1·11	6·11	0·44	0·54	7	7
Aug.	+16·94	+ 5·03	727·62	568·12	85·7	108·7	0·70	1·46	0·51	0·68	8	3
Sept.	+12·66	+ 0·31	728·62	567·20	78·1	35·1	2·62	1·36	0·36	0·55	16	8
Oct.	+ 7·48	− 3·75	723·13	559·82	60·4	108·5	1·24	3·03	0·67	0·62	6	10
Nov.	+ 5·97	− 3·81	727·87	563·72	76·0	141·0	0·58	2·75	0·58	0·54	9	10
Dec.	− 1·38	− 6·03	730·51	564·37	23·7	48·9	1·34	3·04	0·87	0·33	1	19
Year	+ 8·49	− 2·26	727·11	563·86	737·7	1119·5	1·28	2·55	0·60	.0·56	79	107

The mean temperature of Geneva for 1850 was about $\frac{1}{2}$ a degree less than for the ten years 1841–1850; and that of St. Bernard $\frac{4}{10}$ of a degree less. The greatest cold at Geneva was on the 11th of January, when it was −13° 2 C.

The column of barometric observations for St. Bernard, give the mean pressure at noon. The mean pressure at 6 A. M. for the year is 0·35$^{\text{mm.}}$ less than at noon; at 6 P. M. 0·02$^{\text{mm.}}$ greater than at noon; at 8 P. M. 0·19$^{\text{mm.}}$ greater; at 9 P. M. 0·25$^{\text{mm.}}$ greater.

The rain and snow was of less amount than usual, and especially so at St. Bernard. The relative quantity for the seasons at Geneva was 12 p. c. in winter, 33 p. c. in spring, 26 p. c. in summer, 29 p. c. in autumn; and at St. Bernard, 29 p. c. in winter, 27 p. c. in spring, 18 p. c. in summer, 26 p. c. in autumn. Thunder was heard 22 days at Geneva, two times in each April and May, five times in each June, July and August, and three in September.

The northeast winds were unusually intense during 1850, especially at St. Bernard. In February, August and November, southwest winds prevailed at Geneva, and northeast at St. Bernard; and in May, the reverse was true. In the column of winds above, the ratio of N. E. to S. W. winds is given.

The sky was rather clearer than usual at Geneva in autumn, and somewhat less so in summer. At St. Bernard, the winter was clearer than usual, and the other seasons scarcely varied from the mean.

9. *Gold of Australia.*—We cite the following from a pamphlet on the Australian gold by Rev. W. B. Clarke, for which we are indebted to its author. The particular locality where gold was first discovered in 1851, was at the junction of Summer Hill creek with the Macquarie, 33 miles west of Bathurst and about 170 miles west of Sydney.*

"Years ago gold was found in small specimens by the earliest convicts; but the value of the indications was not then known, and the facts were concealed. In 1841, the author of these remarks again brought gold from the very basin of the river now supplying it: this gold was exhibited to members of government and of the legislature, in the Council Chamber itself, and to numbers of persons in the community, who have testified to the fact; it was spoken of openly; it has been discussed in public journals; it was made the ground of inquiries into the probable extensive auriferous character of the colony, and from the result of those inquiries, conducted on scientific principles, and backed by occasional additional proofs, it was openly declared, that gold exists in "considerable abundance" in our "schists and quartzites;" and further, the very region was pointed out in which it would be found. Still no one seemed willing to profit by the disclosure, made as it was cautiously, for reasons which can be appreciated when it is considered that the country was still a penal settlement. The fact was not doubted, but the public mind was directed to another channel. So, in England, though an illustrious geologist had declared his suspicion, that Australia offered in some respects a parallel to the Ural, and though another in Russia had done the same; and though the former had spoken, so late as 1849, to the Ministers of England, upon the subject of gold in Australia, all the encouragement he received was in being told not to let them '*have too much of a good thing.*'

It is not necessary now to detail the careful processes by which the author had convinced himself, that gold must exist in "cosiderable abundance," and that it would be found along the 149th meridian, to which he recommended, in 1850, the then expected geologist to be sent: nor is it necessary, to the vindication of scientific claims, to draw any comparison between his own convictions and the experience of others. The fact which he would insist on is, that it was left for one who makes no profession of geological science, but who had been in California, and by dint of observation, perseverance, and a series of fortunate accidents, was enabled to arouse attention, to excite the public to explore the very region, long known and previously proclaimed, as abundant in gold."

10. *Dead Sea.*—Humboldt states in his "Views of Nature," that M. Valenciennes had received beautiful specimens of *Porites elongata*, Lamk., from the Dead Sea. It is not mentioned whether this coral occurred where the water is supersaturated with salt, or only in the estuaries of rivers.

The following account given by Mr. Monk (son of the Venerable Bishop of Gloucester and Bristol,) of his feelings on first seeing and on taking leave of the shores of the Dead Sea, deserves special notice, not only because it appears true to nature, but because it suggests to

* The remark cited from Rev. Mr. Clarke, on p. 119, of this volume, should read "90° east of the Australian range" instead of "90° west of the Urals."

the mind the suspicion that other travellers, who have described the same scene, have been influenced by preconceived opinions, to see every thing in a gloomy point of view:—

"In about three hours, we reached the mountain brow looking down upon the valley of the Jordan; and delightfully that beautiful strange scenery burst upon our weary and dazzled eyes.

Far from looking gloomy or curse-stricken, it was the most *riant* scene I had yet beheld in Palestine. The Dead Lake itself was as brightly blue as those of Italy; the mountains of Moab and the Ammonites lifted their lofty line against the early sun, and wore a purple hue over their multiplied cliffs and promontories."

"Then came sunrise, first flushing the light clouds above, then flashing over the Arabian mountains, and pouring down into the rich valley of the Jordan. The Dead Sea itself seemed to come to life under that blessed spell, and shone like molten gold among its purpled hills.

I lingered long upon that mountain's brow, and thought that, so far from deserving all the dismal epithets that have been bestowed upon it, I had not seen so cheerful or attractive a scene in Palestine. That luxuriant valley was beautiful as one great pleasure ground, with bosks and groves of aromatic shrubs, intermingled with sloping glades and verdant valleys. The City of Palms might still be hidden under that forest, whence the old castle just shows its battlements. The plains of Gilgal might still be full of prosperous people, with cottages concealed under that abundant shade; and that dread Sea itself shines and sparkles as if its waters rolled in pure and refreshing waves 'o'er coral rocks and amber beds.'

The roads from hence to Jerusalem is drear and barren, and nothing but Bethany occurred to divert my thoughts from dwelling on the beautiful Dead Sea."—*From an article on the Dead Sea, by Dr. R. J. Graves, in Jameson's Edinb. J.*, li, 315.

11. *On the rapidity of the fall of Rain;* by M. Rozet, (Comptes Rendus, 1851, Nov. 24, 581.)—During a calm, the rain falls vertically, and, in such a case, a rail-car in rapid motion, affords a means of measuring the rapidity of the fall of the rain drops. The window of a car is a rectangle, the sides of which are vertical and therefore parallel, when at rest, to the lines of the falling drops. But immediately on giving the car motion, the drops appear to be inclined in a direction the reverse of the motion of the car, though still parallel to one another. One of the drops on its descent passes, say, by the upper angle of the window, and continues on so as to pass the vertical side, at a certain point in its height. If a line be drawn through this point parallel to the top of the window, we have a rectangle the horizontal side of which is to the vertical, as the rate of motion in the cars to that of the falling drop.

M. Rozet, when on a journey between Beaune and Dijon, encountered a shower of rain of large drops, the rate of the cars was 40,000 meters an hour; and this gave 11 meters a second for the rapidity of the fall of the rain.

12. *Means of preserving indefinitely Monuments consisting of Marble or Limestone;* by M. Rochas, (Comptes Rendus, Dec. 1, 1852, 622.)—M. Rochas observes that the calcareous marbles least liable to change or wear from atmospheric causes, are those containing silica in a state of

combination, and not as a mere mechanical mixture. Following out this idea, he has succeeded in subjecting limestone to a process of "*silicatisation*," by which it is partly changed to a silicate of lime. He suggests that valuable monuments and ancient relics of marble, undergoing disintegration and sometimes so soft that they can hardly be handled after exhumation, may in this way be rendered firm and enduring.

13. *Annual Mortality of various Cities of the United States, and other places.*—We extract the following from a valuable paper on the sanitary condition of New Orleans, by J. C. SIMONDS, M.D., from the Charleston Medical Journal and Review, Sept., 1851.—I here present the mortality of the cities of the United States, carefully calculated by myself from authentic data. The data, the principles of the calculation, and the authorities, will be hereafter published, the result only being here given.

Average Annual Mortality of various Cities of the United States.

Boston,	39 years,	1811 to 1849,		2·4572
Lowell,	13 "	1836 to 1848,		2·1194
New York,	45 "	1805 to 1849,		2·9622
Philadelphia,	34 "	1807 to 1840,		2·5510
Baltimore,	14 "	1836 to 1849,		2·4917
Charleston,	27 "	1822 to 1848,	Whites,	2·4826
			Blacks,	2·6458
			Both,	2·5793
Savannah,	8 "	1840 to 1847,	Whites,	4·1616
New Orleans,	4⅓ "	1846 to 1850,		8·1017

Annual average Mortality of other places.

Massachusetts,* 1847–'48,		1·59
Twelve counties of England,†		1·93
Twenty-six cities† "		2·72
London,‡	Males,	2·74
	Females,	2·31
Liverpool,‡	Males,	3·53
	Females,	3·15
Liverpool,§ 1850,		2·73
Manchester,§	Males,	3·65
	Females,	3·31

14. *Eruption of Mauna Loa*, (From the Polynesian of Aug. 23d, 1851; communicated to the editors by D. D. BALDWIN.)—A Hilo correspondent under date of August 12, writes, "The great crater on Mauna Loa that was generally thought to be quite extinct, is now in action. For a few days a heavy cloud, having the appearance of smoke, has been observed to hover over the summit of the mountain. Last night the mountain stood out in bold relief, unobstructed by clouds or mist, and presented a sublime and awfully grand appearance, belching forth flames and cinders that fell again in showers at a distance."

A subsequent communication reports the eruption as having continued twelve days.

* Calculated from Registration Reports. † Dr. Jarvis on Vital Force.—Appendix.
‡ M'Culloch's British Empire. § Chambers' Edinburgh Journal, March 1, 1851.

15. *Electro-Telegraphic Progress*, (Athen., No. 1261; from the Builder.)—The Submarine Telegraph Company are getting made several new metallic cables, in addition to that already in operation—one conductor being already insufficient to convey the multitude of despatches now exchanged between London and the continent. The facility and certainty with which the telegraph has worked, have already effected a great revolution in commercial arrangements, which would be thrown into confusion by the rupture of the communication. Night and day it is carried on. There is still a space of about a mile (from East Cliff to the Southeastern Telegraph Office) unconnected by the wires. The distance has to be done by horse express, and, consequently, causes a few minutes break in the communication. The desideratum is, however, to be speedily supplied. The number of telegraphic stations now open and in connection with the central station of the Electric Telegraph Company in Lothbury, amounts to 226, embracing all the principal towns in the kingdom. Nearly seventy are principal commercial stations, at which the attendance is day and night: the length of the lines of communication extend over 2,500 miles, with 800 in progress of suspension. Since the partial reduction of charges, it is said, persons of all classes are availing themselves of its advantages for business purposes.

16. *Gutta Percha in Photography*, (Athenæum, No. 1261.)—At the meeting of the Photographic Club on Saturday last, Mr. Fry exhibited some charming pictures on glass, obtained by a combination of gutta percha and collodion. To the ordinary collodion—gun-cotton dissolved in ether—a small quantity of gutta percha is added, which readily dissolves. This is employed with the ordinary materials for the processes on glass,—the picture being developed by pyro-gallic acid. The extraordinary sensibility of this preparation may be inferred from the fact, that a positive copy from a glass negative has been obtained in five seconds by gas-light. The film formed on glass is far more adherent than the ordinary collodion or albumen:—we may, therefore, expect many valuable results from Mr. Fry's discovery.

17. *Perturbations of Uranus*, (Athenæum, No. 1261.)—The Paris correspondent of the *Literary Gazette* says:—"A curious fact for astronomers has just been ascertained. In the papers of the celebrated Lalande, recently presented to the Academy of Sciences by M. Arago, there is a note to the effect that so far back as the 25th of October, 1800, he and Burckhardt were of opinion, from calculations, that there must be a planet beyond Uranus, and they occupied themselves for sometime in trying to discover its precise position."

18. *On the Structure of the Lunar Surface, and its relations to that of the Earth*; by James Nasmyth, Esq., (Jameson's Edinburgh New Phil. Journal, li, 267, 1851.)—Some of the principles brought forward in this paper by Mr. Nasmyth, will be found in a paper by J. D. Dana in this Journal, 2nd series, ii, 335–355, 1846, and iii, 94, 1847.

19. *Apteryx.*—A live apteryx has reached the zoological gardens, London.

OBITUARY.

James E. Dekay.—Dr. Dekay died on the 21st of November last, at his residence on Long Island, at the age of 59. He is extensively known for his various researches in natural science. He was educated for the medical profession, and pursued his studies in Edinburgh, Paris and Germany. His travels at this time extended into Turkey, and in 1831, 1832, he published his *Sketches of Turkey*. After his return, his attention was soon given to the study of natural history, and the principal results of his labors are found in many articles published in the Annals of the Lyceum of Natural History of New York, and in his voluminous reports in 4to, on the Zoology of the State of New York. In the social relations of life, his uprightness, amiability and cheerful temperament, endeared him to all who shared in his acquaintance. The vast labors, demanded of him in the preparation of his State Reports on Zoology, impared his health, which he never afterward fully regained.

Prof. EDWARD LASSELL.—Prof. Lassell, till recently Professor of Chemistry in Williams College, Mass., died at Auburndale, near Boston, on the 31st of January last, aged 40.

VI. BIBLIOGRAPHY.

1. *Correspondence in relation to a universal system of Meteorological Observations for the Sea as well as for the Land.* 30 pp., 12mo.—A proposition to the United States government from Great Britain, to coöperate in a system of meteorological observations at foreign stations, commences the correspondence in this pamphlet. Lieut. Maury, U.S.N., who is laboring so assiduously in this department, and to whom the above proposition was officially communicated, discusses the importance of such a system of combined effort, setting forth the steps necessary to ensure success, and the benefits to accrue to science and the world. He suggests that the plan should include France, Germany and Russia as well as Great Britain; also, that it should embrace the sea as well as the land, and that the merchant and naval service equally with foreign consuls should be enlisted. For this purpose, a meteorological conference is proposed, and communications have been addressed to the diplomatic functionaries of the various governments in Washington, requesting them to bring the subject to the notice of their governments. Great results would undoubtedly follow from such a conference: and we should hope that it might end, not only in a uniform plan of operations, but also in a uniform scale for the different instruments. An incalculable amount of computation for the comparison of observations would thus be saved.

2. *Fifth Annual Report of the Board of Regents of the Smithsonian Institution.* 326 pp., 8vo. Senate Doc., Special Session, March, 1851. —The Smithsonian Institution is doing a noble service for the country in various ways. Systematic scientific researches and explorations are encouraged by it, plans and directions as to modes of investigation are published and distributed, and efforts are made to give uniformity to the instruments and other means of observations.* Prof. S. F. Baird, the Assistant Secretary, a thorough and accomplished naturalist, has special charge of natural science. Scientific memoirs of high value, often with expensive illustrations, are brought out and placed within the reach of the public, thus giving an impetus to research and at the

* See our citation, page 288.

same time distributing its results among those who will render them available to the country. A library of indefinite extent is in the course of collection, and the labors of the able librarian, Mr. Jewett, are devoted also to the general progress of libraries throughout the country. By these and other modes, the will of Smithson is faithfully carried out by the Institution under the direction of Prof. Henry, its learned Secretary. The Report gives details of its various operations of a most gratifying kind.

3. *On the connection of Geology with Terrestrial Magnetism*, showing the general polarity of matter, the meridional structure of the crystalline rocks, their transitions, movements and dislocations, including the sedimentary rocks, the laws regulating the distribution of metalliferous formations and other terrestrial phenomena; by EVAN HOPKINS. 2nd edition, 200 pp., 8vo, with 30 plates and numerous wood-cuts. London, 1851.—The above title gives a general view of the contents of Mr. Hopkins's works. The prime idea at the basis of his speculations and conclusions, is found in magnetism.

4. *Photography:* a Treatise on the Chemical changes produced by Solar Radiation and the production of Pictures from Nature by the Daguerreotype, Calotype and other Photographic processes; by ROBERT HUNT, Prof. of Mech. Science in the Museum of Practical Geology, author of Researches on Light, the Poetry of Science, etc.; with additions by the American editor. 266 pp., 12mo. New York, 1852. S. D. Humphrey.—Prof. Hunt, the author of this work on photography is well known for his able investigations in this department of the arts, and his profound knowledge of many branches of physical science. His work is the result of experience as well as study, and should be in the hands of all engaged in photographic operations, both the professed artist and the amateur. The author treats of the history of the science, its theory, and its various processes on paper, silvered plates and other materials, giving all the minuteness of detail required by a learner in the subject, including everything published up to the date of publication, 1851. Among the additions by the American editor is a chapter on the American daguerreotype process. The book is well illustrated by wood-cuts representing instruments, besides containing portraits of Daguerre and Neipce, and two lithographs representing a positive and negative photograph.

5. *The Indications of the Creator, or the Natural Evidences of Final Cause*; by GEORGE TAYLOR. 282 pp. 12mo. New York, 1851. C. Scribner.—The object of this volume is to sustain the idea of a personal Creator, against certain pseudo-scientific arguments, and at the same time to present a review of the more interesting discoveries in science. The development theory occupies a large part of the volume,—perhaps not too large, considering the extent to which the views of the Vestiges of Creation have been circulated. Yet a reader might gather the idea that science was largely falling into this line of error, instead of the actual fact, that no scientific man in Britain or America, had given his name in support of the theory in any publication, and more than this, that science has stood so firmly against it, and especially geologists, that the author of the Vestiges, in his supplement, actually endeavors to prove that men of science, are men of one idea and therefore not competent to judge.

6. *Occultations visible in the United States during the year* 1852; computed by JOHN DOWNES, at the expense of the fund appropriated by Congress for the establishment of a Nautical Almanac, published by the Smithsonian Institution. 34 pp., 4to. Washington, 1851.

7. *Catalogue of Malayan Fishes.*—The Journal of the Asiatic Society of Bengal for October and December, 1849, contains an elaborate catalogue of the Malayan fishes, with annotations and descriptions, by THEODORE CANTOR, Esq., M.D., of the Bengal medical service. It occupies 460 pages.

8. *Ray Society: British Nudibranchiate Mollusca, with figures of all the species;* by J. ALDER and A. HANCOCK, Part V, 4to. London, 1851.—This volume is the second and remaining volume, of the Ray Society publications, for the year 1850. It contains sixteen 4to lithographic plates, partly colored, illustrating numerous species, and giving details of structure. Part VI will finish this valuable work.

Ray Society: The British species of Angiocarpous Lichens, elucidated by their Sporidia; by the Rev. W. A. LEIGHTON, B.A., &c. London, 1851. 102 pp., 8vo with 30 plates.—This work appears as the first volume for 1851; the second will be a monograph on the Cirripeds by Mr. Charles Darwin.

The Ray Society is contributing much to the progress of science and especially British science. The works published are of high value and authority, and are copious in their illustrations of species. Subscriptions (the sum is a guinea a year) are solicited from all interested in science.

9. *An Introduction to the Atomic Theory;* by CHARLES DAUBENY, M.D., F.R.S., &c. 2nd edition greatly enlarged. 502 pp., 16mo. Oxford, 1850.

10. *Annals of the Lyceum of Natural History of New York.* Vol. V, No. 3, pp. 78–120, and Nos. 4, 5, pp. 121–184.

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11. *Journal of the Academy of Natural Sciences of Philadelphia,* 2nd ser., Vol. II. Part II. pp. 81–184, 4to, with plates 10–16. Philadelphia, 1852.

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15. I. Lea: On the genus Acostæa of D'Orbigny, p. 125.

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Proc. Acad. Nat. Sci. Philad., vol. v, No. 12. NOVEMBER, 1851.—p. 307, A new fossil Crocodile, C. antiquus; *J. Leidy.*—p. 308, New Cetacea from the Miocene of Virginia (Balænæ); *J. Leidy.*—p. 310, Synopsis of the species of Donacia (Fabr.) inhabiting the United States; *J. L. Le Conte.*—p. 316, Zoological notes, (new species of Ophiolepis, Ophiothrix, Planariæ and Zoantha); *J. L. Le Conte.*—p. 320, On some American fresh-water Polyzoa, with a plate; *J. Leidy.*—p. 324, On some specimens of Adipocire and fragments of human bones found together; *J. Rommel, Jr.*—p. 325, New fossil reptilian and mammalian remains, including two species of Cetacea, from the cretaceous formation in New Jersey, belonging to a new genus, Priscodelphinus, *Leidy*, which are the first mammalia that have yet been found in cretaceous beds.—p. 328, On the locality of the fossils from the "Mauvaises terres" of Missouri; *Dr. Owen.*—p. 329, Fossil Chelonia, &c., from the Green sand of New Jersey; *J. Leidy.*—p. 331, Note on the Rhinoceros nebrascensis and R. occidentalis, *Leidy*, as belonging to Kaup's subgenus Acerotherium; *J. Leidy.*—p. 331, Synopsis of the Lampyrides of Temperate North America.—p. 347, Descriptions of birds of the genera Laniarius, Dicrurus, Graucalus, Manacus and Picus, specimens of which are in the collection of the Academy of Natural Sciences of Philadelphia; *J. Cassin.*—p. 349, Contributions to Helminthology; *J. Leidy.*—p. 352, Librarian's Report, showing an increase in the Library during the year of 1735 volumes and 521 pamphlets.—p. 352, Report of the Curators.—p. 355, Report of the Treasurer.

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FACE OF A CHINESE CLOCK.

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[SECOND SERIES.]

Art. XXVII.—*The Permeability of Metals to Mercury;* by Prof. Horsford of Harvard.

Daniel observed that bars of lead, tin, zinc, gold and silver, became penetrated by mercury, when partially or wholly immersed in it. He noticed that mercury combined to form a crystallized amalgam* with each of the first four metals and by the aid of heat, also with silver.†

Henry modified the experiment of Daniel, with lead, giving to the bar the form of a syphon, one end only of which was immersed in the mercury. He discovered the remarkable fact that the mercury may not only be carried through the bar in this form, but that it will drop from the longer section of the bar, thus exhibiting the syphon experiment, employing a solid bar for the tube and mercury for the liquid.‡

I have repeated the experiments of Daniel and Henry, and have modified them in a variety of ways to meet the inquiries suggested in the investigation of these phenomena, and I propose

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* Annals of Roy. Inst., vol. i.

† Böttger prepared amalgams of barium, manganese, cobalt, nickel, zinc, silver, lead, copper and cadmium, by pouring salts of these metals upon sodium amalgam. Klauer observed the formation of calcium and magnesium amalgams, upon pouring salts of these metals upon potassium amalgam. Wollaston, Berzelius, Davy, Bergmann, Damour, Döbereiner, Serullas and Tennant have made various researches in this field. The production of amalgams by electrolysis are well known.

‡ Pogg., 52, 187.

to give, in the following paper, the results at which I have arrived.*

Experiments with Lead.—The bars employed by me, with a few exceptions for specified purposes were cast in paper moulds surrounded by sand, of a diameter varying but slightly from ·006 mm., and of variable lengths to suit the objects of experiment. The following inquiries were submitted to experiment.

I. *Has the bar saturated with lead increased specific gravity?*

Bars of lead, after standing in a cup of mercury until they had become saturated with the latter metal, were taken out and carefully scraped to remove the surface coat, and the specific gravity ascertained in the usual manner. The following determinations were made.

Sp. gr. of lead.		Sp. gr. of lead and mercury.	
11·431	drawn bars.	11·409	drawn bars.
11·405		11·426	
11·407		11·436	
		11·415	
11·414 average.		11·421 average.	
11·423	cast bar.	11·464	cast bar.
11·405			
11·387			
11·405			

They seem to indicate increased specific gravity.

The irregularity of these results led to an experiment to ascertain if there might be cavities in the bar. The specific gravity of mercury being greater than that of lead, as 13·575 (Fahrenheit) is to 13·445 (Berzelius), a bar containing cavities would have when saturated with mercury a higher specific gravity than a bar without cavities, similarly saturated.

The following are the weights before and after being saturated with mercury.

		Increased to
I.	4·6342 gr. of lead. . . .	4·6730 gr.
II.	4·8403 " " . . .	4·9190 "
III.	6·2051 " " . . .	6·3153 "

	Increase.
I.	0·0388 grammes.
II.	0·0787 "
III.	0·1102 "

The result was unsatisfactory, nearly equal weights of lead had apparently absorbed weights of mercury differing from each other by a hundred per cent.

* I met with the first exhibition of the experiment of Prof. Henry in the laboratory of Prof. Ten Eyck of Albany.

Upon examining the bars where in contact with the mercury they were corroded and lead was found dissolved in the mercury. More lead might have dissolved from one bar than the other.

Another experiment made to determine the expansion of a bar of lead, by the absorption of mercury, to which reference will be made below, confirms the opinion of higher specific gravity of the amalgam.

II. *What is the velocity of transmission of mercury through lead?*

It was observed by Prof. Henry that the progress of mercury was more rapid in cast than in hammered lead. Upon noting the progress from day to day, most unexpected results have presented themselves. In a vertical bar with the mercury at the bottom, the progress is at first rapid. It diminishes in velocity however from day to day, until after several months having reached a height of between six and seven inches, it is not one thousandth as rapid as at the outset.

A hollow bar of lead of ¼th inch calibre was erected in a cup of mercury. The latter metal rose

In	6 hours,	0·062 mm.
"	18 hours more,	0·008 "
"	12 days "	0·028 "
"	8 " "	0·008 "
"	11 " "	0·010 "
"	112 " "	0·014 "
"	53 " "	0·007 "
"	53 " "	0·006 "
"	53 " "	0·012 "
Total,	313	0·155*

In two cast bars it rose somewhat more rapidly, and to a total greater height. In one (a) the velocities were as follows.

In	24 hours,	0·085 mm.
"	24 hours more,	0·010 "
"	16 days "	0·002 "
"	90 " "	0·054 "
"	53 " "	0·021 "
"	53 " "	0·005 "
Total,	234 "	0·177 "

* The mercury arose in a second similar hollow bar,—

In	24 hours,	0·075
"	6 days more,	0·055
"	20 " "	0·014
"	53 " "	0·011

It had previously been saturated with mercury but had apparently lost most of its mercury by evaporation.

In the other (b) which was composed of short pieces fused together the mercury rose

In 169 days,	. . . .	0·224 mm.
" 47 days more,	. . . .	0·011 "
" 53 " "	. . .	0·015 "
Total, 269 "		0·250 "

Placing these results side by side we have the ascent of mercury in twenty-four hours

In drawn lead,	. . . .	0·070 mm.
" cast "	. . . . .	0·085 "

The total height to which the mercury rose during the time of experiment

In drawn lead,		= 0·143 mm.
" cast "	(a)	= 0·177 "
" " "	(b)	= 0·250 "

The last result confirms a further remark of Prof. Henry, that the mercury follows the seams of a cast bar, rather than the more homogeneous portions. It is obviously a case of capillary attraction, the mercury ascending between the walls of narrow fissures.

III. *Does gravity influence the transmission of mercury?*

Mercury was presented at the top of a bar 0·80 mm. in length. Its descent was astonishingly rapid. In two hours it had penetrated ·360 mm. The first quantity having all passed into the bar it ceased to flow. Upon the addition of another portion the flow was resumed. In less than two days the mercury dropped from the bottom.

A syphon shaped bar with the *shorter leg* out of the mercury, though it became saturated discharged no mercury.

Gravitation evidently facilitates the transmission of the mercury when flowing from above downwards. It of course opposes its flow from below, upward.

IV. *Does the mercury which passes through the bar of lead contain the latter metal in solution?*

The drop presents a film upon its surface, which, as in a sack, of very considerable tenacity, encases the purer metal. Upon volatilizing the mercury at a low heat under a mass of cyanid of potassium, carbonate of soda and sand, there remained a button of lead.

V. *Is the lead contained in the bar derived from the end of the longer leg of the syphon, or from the interior of the bar as well as the end?*

In the latter case the interatomic spaces would be increased, and the mercury under the influence of capillary attraction and gravitation, might be expected to flow faster. To ascertain if this might be, a syphon bar was arranged, of diameter ·006 mm.—total length one decimetre. The amalgam dropped into a weighed porcelain cup, and was determined at intervals of ten days, and finally after a lapse of but four, emptying the cup after each weighing. The quantities that flowed through in the periods to ten days were—

1st ten days,	5·4169
2d, " "	5·7906
3d, " "	8·6281
4th, " "	11·4976
5th, " "	15·4280
6th, " "	18·9119
7th, " "	24·6699
8th, " "	29·5954
9th, " "	34·6036
10th, " "	40·0351
4 days more gave,	17·3920
equal for ten days to, 43·4806	
Total, 104 days,	211·9691

It will be observed that the quantity flowing through in the last four days of experiment was not as great a proportional increase as that of the preceding ten days.

A second experiment was made with another bar, employing the same mercury, now more or less saturated with lead.

The length of the bar was 0·070 mm. and the diameter 0·006 mm. The first two weighings were at intervals of ten days, the remaining weighings once in five days.

There dropped in the

1st and 2d five days,	48·2735	grammes.
3d " 4th " "	66·5655	"
5th, " "	31·6409	"
6th, " "	29·7585	"
7th, " "	31·3590	"
8th, " "	30·1640	"
9th, " "	35·3460	"
10th, " "	39·9694	"
11th, " "	36·0043	"
12th, " "	31·2365	"
13th, " "	31·5286	"
14th, " "	31·9990	"
Total, 70 days,	443·8452	"

The first suite of experiments led directly to the conclusion, that the increased flow of mercury in a given time, was due to the increased porosity of the lead—to increased capillary attraction. The second suite of experiments did not sustain this conclusion. In the first place contrary to expectation a new bar transmitted more mercury, than the bar conceived to have become highly porous by use. And in the second place the quantity transmitted in a given time, soon attained a maximum from which it varied but little to the close of the experiment.*

The 5th, 6th, 7th, 8th, 12th, 13th and 14th weighings gave quantities varying but little from each other. The 9th exceeded any of the preceding determinations so much that I was led to a careful inspection of the circumstances attending the experiment. I found the bar more deeply immersed in the mercury. Its position was maintained for the two succeeding experiments, and then changed to that occupied at first. These weighings led to the opinion that the cause of the discrepancy was the unequal absorbing surface, to which the mercury had been exposed. More mercury had passed into and through the bar in one case than the other. This view was confirmed by an especial experiment to ascertain

VI. *What is the influence of the extent of absorbing surface exposed to the mercury?*

Two bars of equal length and diameter were taken. They were bent into syphons and the shorter leg dipped in a solution of gutta percha in chloroform—a sort of collodion which incrusted them with an impermeable envelope. After drying, the gutta percha cuticle was scraped from the end of one bar—and from the end and nearly an equal portion of the side of the other. The shorter legs of both were placed in the same cup of mercury and the longer legs in other weighed cups.

Two drops fell from the bar having the larger surface before any fell from the other. After nine days the quantities were weighed. Through the bar having the greater absorbing surface there had flowed, ... 3·8902 gr.

Through that having less, . . 2·1285 "

It might be supposed that the syphon action would be limited by the height to which the mercury rises in a vertical bar. An experiment was made to ascertain

VII. *Whether the ascent of mercury be influenced by the vertical elevation of the summit of the syphon, above the mercury, or the length of bar between the mercury and summit?*

A bar was saturated with mercury and then bent into the form of a syphon—the shorter leg being 0·150 mm.—the longer 0·800 mm. in length. At the end of thirty-four days, there had appeared no drop. At this period the shorter leg was inclined at an angle of 15° to the horizon. In 129 days no amalgam had dropped from the longer leg. As the bar was saturated with mercury, the height to which the latter metal rose in the syphon

* Experiments undertaken since this paper was sent to the Journal, show that the above conclusions may require some modification. At the close of the above series of experiments, the quantity of mercury passed in 5 days was a fraction less than 32 grammes. At this stage, the surface of the bar-syphon was rubbed so as to remove the coating of suboxyd and present a continuous amalgam. Thereafter the flow of mercury rapidly increased, until at the date of this note (March 8) a bar-syphon less than 0·006 mm. in diameter and 0·070 mm. long, discharges in 24 hours, the extraordinary quantity of 40· grammes.

could not be ascertained. It is evident nevertheless from this experiment and those detailed under inquiry (II), that the progress of mercury is so slow after having penetrated some 0·150 to 0·200 mm. of mere length, that length influences more than vertical height. From the results of the first and second series of experiments, arose naturally the inquiry,

VIII. *Does the mercury saturated with lead flow through leaden bars?*

The following experiments were made.

1st. Two syphon-shaped bars were placed in mercury that had once run through lead. In three days drops fell from both.

2d. Mercury in which lead had been standing for months, and which was viscid from the presence of crystallized amalgam, was taken, and two bar syphons, one saturated with mercury and the other pure, were placed in it. In due time the amalgam fell from both.

3d. Three syphons of nearly equal length were placed in a cup of mercury. In due time the amalgam dropped from all. In a few days the cup was emptied. As it ran through it was received into a second cup, from which when the first was emptied, it was poured back, to run through a second time, and a third, and so on.

The amalgam thus ran through some twelve or more times. It was saturated when it first came through, for it had every facility for acquiring the largest measure of lead it could hold. In this condition it ran repeatedly through the bars.

The quantity of liquid amalgam diminished, and there accumulated in the cup, at each end of the bar, crystallized amalgam. The mercury had evidently evaporated.

Bars brittle when first withdrawn from the mercury in time recovered their tenacity, and apparently, with the loss of mercury by evaporation. This led to analyses in answer to the inquiry,

IX. *What is the constitution of the bar saturated with mercury when in contact with the mercury, and also after long exposure to the atmosphere?*

An analysis of the saturated bar—the lead determined as sulphate* and the mercury as sulphide, gave of

* An analysis of the saturated bar, by fusing under a mixture of carbonate of soda, cyanid of potassium and sand, gave of

Lead,	96·53
Mercury,	3·47
	100·00

Another gave of

Lead,	94·25
Mercury,	5·75
	100·00

It was obvious that if the loss by vaporization in one case embraced all the mercury, it included some of the lead in the second.

I.	Lead,	96·32
	Mercury,	3·63
		99·95

II. Another analysis of the same gave of

Lead,	96·39
Leaving of mercury,	3·62
	100·01

I. An analysis of the bar after seven months exposure to the atmosphere, gave of

Mercury,	0·83 per cent.
Leaving of lead,	99·77 " "
	100·00

II. Another analysis gave of

Mercury,	0·88
Lead,	99·22
	100·10

The mercury was determined by treating the bar with dilute nitric acid, and stopping the action, as soon as the mass assumed a globular form. By this process the lead being a more highly electro-positive body would alone have been dissolved, and there would have remained of the lead only so much as belongs to the liquid amalgam which was found not to exceed two per cent. The lead was determined in the second case as sulphate.

X. *What is the constitution of the amalgam which flows through the bar?*

An analysis gave by precipitation of the sulphate of lead from the nitric acid solution, in

2·7348 gr. of amalgam,
0·1008 " of sulphate of lead, } =2·52 per cent. of lead,
leaving 97·48 per cent. of mercury.

An analysis of the solid crystalline amalgam, which formed about the bar, when in contact with the mercury gave of

Lead,	36·03 per cent.
Mercury,	63·97 " "
	100·00

A cast bar, the surface of which was not scraped, after a little time lost no more of its mercury as the following weighings show,

Weight,	4·0476	difference.
20 days later,	3·9971	−0·0505
10 " "	3·9975	+0·0004
10 " "	3·9978	+0·0003

At first the mercury on the outside and ends, was at the surface volatilized. The crystalline amalgam prevented thereafter, the escape of the mercury.

XI. *What change will the saturated bar experience, long in contact with the mercury?*

A straight bar 0·040 mm. long, placed erect in mercury was soon saturated throughout. No sensible change in its texture took place till at the end of one hundred and ninety-four days, the portion just below the summit began to enlarge, and crack open, displaying at the end of a few days crystallized angles and surface in the interior. The crystallization continued for ninety days when the observations were terminated.

All the vertical bars that from the commencement of experiment had remained standing in the mercury, nearly equal periods, cracked open, more or less throughout their entire length.

The syphons employed in experiments under (V), after having been withdrawn from the mercury forty-four days, on being returned to it, did not promptly permit the quicksilver to flow through, but after forty-one days began to crack;—twenty-six days later the mercury resumed its flow.

The velocity of transmission was greatly diminished. In sixty days there fell only 11·4604 grammes. The texture of the bar and the play of affinities had both changed.

XII. *Does the bar expand at once upon becoming saturated with mercury?*

A piece of ¼ inch lead tube was split open, flattened and scraped bright, and its length having been accurately ascertained — ·198 mm, mercury was spread over its entire surface, care being taken to avoid the points where admeasurement had been made, and where expansion if it occurred was to be observed.

When the mercury had penetrated to the lower surface of the bar admeasurement was again made. The bar had not perceptibly increased in length, nor did it, in the first ten days after the saturation with mercury.

Experiments with Tin.—The fact that tin is permeable to mercury was noticed by Daniel. The following inquiries were submitted to experiment.

I. *Is the specific gravity increased by being saturated with mercury.*

The experiment was made with tin before it began to crystallize, and after the crystallization had apparently come to an end.

Spec. gr. of pure tin employed in the experiment,	7·29
Tin saturated with mercury, ...	7·50
Tin and mercury—crystallized amalgam, . .	8·00

II. *What is the velocity of transmission of mercury through tin?*

The bars used in the following experiments were cast in paper moulds surrounded by dry sand. A bar 0·006 mm. in diameter was placed in mercury having 0·185 mm. above the surface of the liquid metal. The mercury ascended as follows—

In the 1st day, . .	0·010 mm.
" " 2d, " . . .	0·010 "
" " 3d, " . .	0·010 "
" " 4th and 5th days, . .	0 022 "
" " 6th, day, . .	0·013 "
" " 7th, " . . .	0 013 "
" " 8th, " . .	0·013 "

At the end of six days the bar began to crack open at the bottom. In fifteen days the mercury reached the top of the bar, 0·185 mm.—making for the last seven days, a velocity of 0·013$\frac{4}{7}$ mm. per day.

The movement of the mercury in tin differs greatly from that of lead. In the latter this progress is by a sort of inverse geometrical ratio, in the former it is remarkably uniform.

A second bar was fitted to the top of the first and secured in a tube by means of corks so as to preserve the contact. The mercury continued to rise, through several days, and attained a total increased elevation of 0·217 mm. Before the mercury had entirely ceased to ascend, the bar below opened into numerous fissures, and the entire column of amalgam became eminently brittle.

It would seem as if the crystallization arrested the play of affinities upon which the ascent of the mercury depended.

III. *Does the tin permit the syphon action?*

A bar of 0·006 mm. diameter, 0·185 mm. total length, was bent into syphon form and the shorter division placed in mercury. In fifteen days the mercury dropped from the bar. In two days more the bar broke of its own weight. The brittleness of the saturated tin bar, taken in connection with the more rapid crystallization, made it impossible to perform the serial experiments undertaken with the lead.

IV. *Does mercury saturated with lead flow through tin bars?*

A syphon of 0·170 mm. total length was placed in a cup containing mercury that had run through lead. In due time the liquid issued from the larger leg of the syphon. Upon analysis, the liquid was found to consist only of tin and mercury—the lead had been left behind. In the bottom of the cup was found a crystallized amalgam of tin and lead.

V. *What is the constitution of the solid crystallized amalgam —the bar of tin saturated with mercury.*

Several determinations were made of both mercury and tin—the former as sulphide, the latter as stannic acid. The mercury determinations were uniformly too high, from the unavoidable presence of free sulphur. The tin analyses follow—

	Tin.	
100 parts of amalgam gave	82 9	per cent.
" " " "	82·3	"
" " " "	82·4	"
" " " "	82·1	"
" " " "	82·4	"
" " " "	82·9	"
" " " "	82·5	"
	577·5	
Average, . .	82·5	
Average of mercury, .	17 5	

These numbers give very accurately the constitution,

$$Hg\,Sn_6.$$

The amalgam that flowed through, gave

Tin, ...	1·55
Leaving mercury, . . .	98·55
	100 00

The amalgam that flowed through, leaving the lead behind, gave—

Tin, ...	1·73
Mercury, ...	98 27
	100·00

VI. *The bar of tin as it becomes saturated with mercury, begins, as remarked above, to crystallize.*

If at an early stage in the crystallization, the bar is bent, the outside cracks off, revealing a pith as distinct as if it had been at first cast, and then a sheath cast around it.

If the crystallization be permitted go on, the fissures penetrate to the centre of the bar. Daniel observed, that a square bar split into triangular prisms—the separating fissures following diagonal planes. If the top and bottom of the bar were right angled terminal planes, the crystallization freed a pyramid, at either extreme.

The bar being irregularly cylindrical, the fissures were formed as in the case of the prism—along the lines of least resistance.

VII. *Does the mercury volatilize from the saturated tin bar?* An affirmative reply might perhaps have been anticipated from the results with lead. In this however as in other respects the tin and lead are greatly unlike.

A bar of tin saturated with mercury was weighed at intervals of ten days. Its weights were as follows—

1st, . .	5·2061 grammes.
After 10 days, . .	5·2061 "
" 20 " . .	5·2061 "
" 30 " . .	5·2061 "

It crystallizes very soon after becoming saturated, and then as in the case of the lead volatilization ceases.

Experiments with Gold.—The progress of mercury in a bar of gold is exceedingly slow. This fact was observed by Daniel. Under favorable circumstances, in a strip of rolled American coin 0·0006 mm. in thickness, the mercury rose, 0·008 mm. in a period of 240 days. The surface of the mercury around the gold was coated, with a coherent solid amalgam.

Mercury coming in contact with gold, as is well known, rapidly combines with it. The depth to which mercury penetrates, seems to be influenced by considerations, something like those which prevail with lead.

Experiments with Silver.—The progress of mercury in silver is scarcely more rapid than in gold. It rose in a strip of American coin 0·00009 mm. thick, but 0·0085 m. in 240 days.

The circumstance that both the above metals were rolled, and of course compressed—and the fact that both were alloys, doubtless impeded the flow of the mercury.

Experiments with Zinc.—A bar of zinc was cast in a crooked glass tube, so as to possess without bending, the requisite syphon form. Upon being placed in mercury it rapidly dissolved all below the surface of the liquid metal. The mercury however penetrated 0·0065 mm., and, in this condition withdrawn from the mercury—retained a semi-liquid drop at the end of the shorter leg, 250 days, that being the period of observation.

Experiments with Cadmium.—A syphon of cadmium was prepared in the manner of the zinc syphon. It dissolved rapidly in the mercury, but there appeared after sometime, an enlargement of the body of the bar 0·006 mm. from the end of the shorter leg, which resembled that in the bars of lead, except that it did not crack open.

Experiments with Platinum, Palladium, Iron, Copper and Brass, gave only negative results. The permeability of several of these metals to molten tin, gold and silver and of iron to molten copper, is well known.

Summary of Results.

1st. The specific gravity of lead is increased by saturation with mercury.

2d. The velocity of mercury diminishes, as the length of the saturated bar increases—and in a kind of geometrical ratio.

3d. The progress is more rapid in cast than in drawn lead.

4th. The total height to which the mercury attains is greater in cast than in drawn lead.

5th. Gravity facilitates the flow of mercury from above downward.

6th. The mercury, which passes through a syphon-shaped bar of lead, contains lead in solution.

7th. This lead is derived from the interior of the bar.

8th. After the transmission of a certain amount of mercury, and the return of this mercury to be passed again, the amount transmitted in a given time attains a maximum.

9th. The amount passed in a given time with a given length of the shorter leg of the syphon, is dependent on the absorbing surface exposed to the mercury.

10th. The syphon action is limited by the same law that determines the height or length of bar, through which mercury will pass.

11th. Mercury saturated with lead passes through leaden bars.

12th. The saturated bar is eminently brittle.

13th. the saturated bar contains—

3·55	per cent of	mercury.
96·45	"	lead.

14th. The bar saturated with, and afterwards withdrawn from the mercury, in seven months lost by atmospheric diffusion—

	2·75	per cent. of	mercury.
Leaving only	·80	" "	in the bar.

15th. In this condition the bar had nearly recovered its original texture.

16th. After the loss of a certain amount by diffusion, the surface becomes coated with crystalline amalgam, and the diffusion ceases.

17th. The liquid amalgam contains 2·52 per cent. of lead.

18th. The saturated bar long in contact with mercury assumes a crystalline texture and cracks open.

19th. After crystallization commences the progress of the mercury is impeded.

20th. The specific gravity of tin is increased by saturation with mercury.

21st. The saturated bar soon opens by numerous fissures, presenting crystalline angles and surfaces.

22d. The specific gravity of the crystallized amalgam is greater than that of the bar merely saturated with mercury.

23d. The velocity of transmission of mercury through tin is at first slower than that through lead, but it differs in being uniform, while the velocity in lead rapidly diminishes.

24th. The syphon action in a tin bar cannot be long maintained on account of the crystallization and consequent brittleness of the bar.

25th. The crystalline amalgam has a constitution of $Hg\ Sn_8$.

26th. The liquid amalgam contains

1·55 per cent. of tin to 98·45 per cent. of mercury.

27th. The crystalline amalgam loses nothing by atmospheric diffusion.

28th. Quicksilver permeates gold and silver but very slowly.

29th. Zinc and cadmium are permeable to mercury, but dissolve in it.

30th. Iron, platinum, palladium, copper and brass, are, at common temperature, not permeable to mercury.

Note.—I am indebted for most of the foregoing analyses to Messrs. Homer, Hague, Dwight, Worcester, Mariner, and Dean, pupils in my laboratory, who have kindly coöperated with me in promoting the research.

Art. XXVIII.—*Extract from the Report of the Board of Officers convened under the direction of Hon. Thomas Corwin, Secretary of the Treasury, on the Light House System of the United States coast.**

Sir: The light-house board have the honor to submit the report of their investigations, and the conclusions they have arrived at, under your instructions of the 21st May, 1851, hereto appended, in conformity to the 8th section of the act making appropriations for light-houses, light-boats, buoys, &c., approved March 3, 1851, in the following words:

"*And be it further enacted*, That the Secretary of the Treasury be, and is hereby, authorized and required to cause a board to be convened at as early a day as may be practicable after the passage of this act, to be composed of two officers of the Navy of high rank, two officers of engineers of the Army, and such civil officer of high scientific attainments as may be under the orders or at the disposition of the Treasury Department, and a

* The great importance and general interest of the subject, have led us to republish the above extract from this Report. The Board of Officers, from whom it originates, consisted of Commodore Wm. B. Shubrick, U. S. Navy, Commander S. F. Du Pont, U. S. Navy, Brevet Brigadier General Joseph G. Totten, U. S. Corps of Engineers, Lieut. Col. James Kearney, U. S. Topographical Engineers, Prof. A. D. Bache, LL.D., Superintendent Coast Survey, Lieut. Thornton A. Jenkins, U. S. Navy, Secretary.

junior officer of the Navy to act as secretary to said board; whose duty it shall be, under instructions from the Treasury Department, to inquire into the condition of the light-house establishment of the United States, and make a general detailed report and programme to guide legislation in extending and improving our present system of construction, illumination, inspection, and superintendence: *Provided*, That no additional compensation be allowed to any person serving on said board."

The board, having entered upon the duties confided to them with a high sense of their responsibilities and importance, have spared neither pains nor labor in seeking to obtain facts, from their own observation and from reliable sources, upon the different points embraced in your instructions. They have sought for useful information also from reliable treatises and from public documents, and have endeavored to reach correct conclusions on the numerous points submitted to them.

The subject of light-house illumination and improvement, although one of occasional discussion in Congress and in certain circles within the last ten years, has not occupied the public mind to any great extent in this country; while in Europe generally, but more especially in France, England, Scotland, and Ireland, the ablest and most distinguished statesman, philosophers, and philanthropists have devoted themselves for the last twenty-five or thirty years to this subject, in endeavoring to apply practically the aids which science and the mechanic arts have developed.

Experiments to ascertain the truthful practical tests of the relative useful and economical value of illuminating apparatus, combustibles, and their accessories, in the most minute detail, have been made by Fresnel, Faraday, Stevenson, and other distinguished individuals; the results of their investigations have been published to the world, and their conclusions have served for the formation of a system for light-house illumination, approximating to perfection.

Legislation, too, has taken a prominent part in this important branch of the public service in Europe.

In 1825 the French government adopted definitively the French system of illumination on the coasts of France, and took, as the basis of their future light-house establishment, the programme proposed by the board organized for the purpose, at the head of which was Admiral Rossel, of the French navy.

About this time the subject, which Sir David Brewster had foreshadowed in 1811, was revived in England and Scotland, through Colonel Colby, of the royal engineers, and Mr. Stevenson, the engineer to the Northern lights, (and the distinguished architect of the Bell Rock tower;) however, no important step was taken on the English side of the channel to introduce the Fresnel apparatus until after a most careful and rigid examination had been made by the light-house engineer of Scotland, and after trials of comparative usefulness and economy with that and the reflector apparatus at the Inchkeith station.

In 1834 a new impulse was given to the subject of improvement in light-house illumination by letters on the subject from Sir David Brewster, and from the action of the House of Commons's select committee on the subject.

The light-house boards of Europe seemed to exert themselves to satisfy public opinion by the introduction of the Fresnel lens at a few of the most important points for land lights, and of improved apparatus for floating lights, consisting of the Argand lamps and Parabolic reflectors in general use for land lights, prior to the introduction of the Fresnel lens, and moveable machinery for converting such fixed floating lights as were necessary into revolving ones.

Although the lens met with much favor in England, and has been gradually getting into use, until nearly one-half the sea-coast lights have been changed since 1837, still Scotland has introduced a larger number, in proportion to extent of coast, than the Trinity-House corporation. Notwithstanding these decided improvements in the lights of Great Britain, another select committee on light-houses was raised by the House of Commons in 1845, and of the benefits arising from this last report, have been the introduction of a large number of lens apparatus, not only in Great Britain, but also into many of the colonies, and the substitution of the colza or rape-seed oil in nearly every light-house in the kingdom, in consequence of its superiority and economy compared to the best sperm oil.

Improvements in illuminating apparatus and construction, ventilation, combustibles, &c., have made rapid progress in light-house engineering in Europe, while in this country no attempt has been made to improve the lights, with the exception of the act of Congress approved July 7, 1838, and which was the result of the recommendation of the Committee of Commerce in the Senate, as follows:

"Sec. 2. *And be it further enacted,* That the Secretary of the Treasury be, and he is hereby, directed to cause two sets of dioptric or lenticular apparatus, one of the first, the other of the second class, and also one set, if he deems it expedient, of the reflector apparatus, all of the most improved kinds, to be imported, and cause the said several sets to be set up, and their merits, as compared with the apparatus in use, to be tested by full and satisfactory experiment."

* * * * * * * * * *

Under this authority a lens apparatus was placed in each of the towers at the highlands of Navesink, and fourteen out of the fifteen reflectors were placed in the Boston light-house.

If "the said several sets" were "set up" and "their merits," as compared with the apparatus in use, tested by full and satisfactory experiment in conformity to the act, the results of those experiments have not been seen by the board, nor have they ever heard that such experiments were made. With this exception, and the authority of Congress "to test Mr. Isherwood's plan of discriminating one light from another, and of determining the distance of a vessel from a light," which resulted in placing a second order lens in the tower at Sankaty head, Nantucket, and the lights authorized by law to be constructed under the direction of the Topographical bureau, (Brandywine shoal, Carysfort reef, and Sand key,) the board have been unable to discover that any steps have been taken to keep pace in light-house improvements in this country with those of France and Great Britain.

The board, after examining, with a patience and a zeal which they believe this important branch of the public service to demand, the different points to which their attention was specially called by the instructions of the Department, have arrived at the following conclusions, which they feel assured will be found to be fully sustained by the detailed data in this report, and its appendix, upon which they are chiefly based.

1. That the light-houses, light-vessels, beacons, and buoys, and their accessories in the United States, are not as efficient as the interests of commerce, navigation, and humanity demand; and that they do not compare favorably with similar aids to navigation in Europe in general, but especially with those of France and Great Britain, and their dependencies.

That the light-house establishment of the United States does not compare favorably in economy with those of Great Britain and France.

That, while the superiority of the European lights to those of the United States (arising from the greater care and attention bestowed upon them, the better and more expensive apparatus employed in them, the larger number of keepers to the lights, the more rigid superintendence and frequent visitations for inspections and for delivery of supplies,) renders any just comparison of them in annual expense in money impossible; it is shown that the difference for maintenance per lamp per annum is very small and that not invariably in favor of those of this country.

That the towers and buildings have not been constructed in general of the best materials, nor under the care and supervision of competent or faithful engineers.

That the want of professional knowledge of the materials, mortars, cements, &c., for construction and repairs, or faithfulness on the part of those charged with the duty, was apparent in nearly all the modern towers and buildings visited by the board.

That the present large sums annually required for renewing, renovating and repairing towers and buildings, are the consequences of the want of an efficient organization, which could afford the necessary professional ability for plans, drawings, and superintending of constructions and repairs.

That the towers are deficient in the necessary proper accommodations for oil and other supplies; in the mode of fitting them up, and in the materials employed for the interior work; and the buildings ill-adapted to the comfortable accommodation of the keepers.

That the lanterns are as a general rule, of improper dimensions, constructed of ill-adapted, and, in the end, not economical materials, without professional or scientific skill; and, in many instances, not suited to the use for which they are designed.

That there is no proper system of ventilation for lanterns.

That the means said to be employed for ventilating are wholly inadequate, and contrary to true scientific principles.

That there is very little attention paid to the painting of the interior of the lanterns and astragals, and in glazing.

That, under a well organized system, the lights, and other aids to navigation might be greatly increased in number and efficiency, at a large saving upon the present annual cost.

That there has never been an efficient systematic plan of construction, illumination, inspection, and superintendence of lights, &c., in the United States.

That towers and buildings have been constructed without regard to the wants of the service, and to the peculiarities of localities, and the special design of the lights themselves.

That the light-house towers, buildings, and vessels visited by the board were not, in general, found to be in a creditable state of preservation and repair.

That the inferiority of illuminating apparatus in the light-houses of the United States renders its renewal frequently necessary, at great expense, and never produces as effective a light as it is capable of making.

That the reflector apparatus employed in the light-houses of the United States is greatly inferior to the requirements of the service, being defective in form, materials, and finish.

That the illuminating apparatus in the United States is of a description now nearly obsolete throughout all maritime countries, where the best apparatus of that description was employed, prior to the introduction of the Fresnel lenses, as substitutes.

That the sea-coast reflector lights are, in general, too low, and are deficient in power and range.

That our sea-coast reflector lights are not fitted with a sufficient number of lamps and reflectors to produce the greatest amount of usefulness, which the imperfect system of lighting with the reflectors will produce.

That the lamps and reflectors are not, as a general rule, properly placed on the frames, due regard not being paid to divergency.

That the sea-coast lights are deficient in proper attendance, with only one keeper.

That there is no proper classification of lights in the United States.

That the lights are not properly and sufficiently well distinguished along the coast of the United States.

That there is no system of public inspection and superintendence, calculated to render the light-house establishment moderately useful or efficient.

That the lanterns, illuminating apparatus, &c., are not superintended, while they are being made, by competent or faithful professional men.

That there are no general or special regulations for keepers and others connected with light-houses, by which to ensure an intelligent or faithful performance of the duties.

That supplies of all kinds, involving the good or bad quality of the lights to a great extent, are not tested and selected by competent persons before issuing them to light keepers.

That there is not a proper degree of responsibility on the part of the agents connected with the light-house establishment.

That the present mode of procuring and distributing supplies, apparatus, &c., is not calculated to ensure either efficiency or economy in the service.

That contractors are not held under a sufficiently rigid superintendence and inspection during the execution of works of construction and repair.

That the modern light-house towers are inferior in point of materials and workmanship to the older ones visited by the board such, for example, as Sandy Hook light-house, built in 1762; Cape Henlopen tower, built in 1764; Cape Henry tower built in 1791.

That the floating lights of the United States are comparatively useless for want of efficient lamps and parabolic reflectors.

That the light vessels are in general not adapted to the service they are required to perform, being defective in size, model, and moorings.

That the light vessels are not properly distinguished either by day or by night.

That sufficient regard has not been had to the proposed use of the several lights, so as to regulate their power and range accordingly.

That there is no effective system by which to afford to sparsely settled parts of the coast requiring lights, the means of bringing the subject before Congress, and of deciding in advance of appropriations the best descriptions of lights to be placed at the desired points.

That many of the small lights have an unnecessary number of lamps and reflectors, while sea-coast lights are greatly deficient in them.

That in the form and adjustment of the reflectors, sufficient attention is not paid to the range and other circumstances of the required lights, involving scientific principles.

That there is not, in useful effect, a single first class light on the coast of the United States.

That the lights at Navesink (two lenses) and the second order lens light at Sankaty Head, Nantucket, are the best lights on the coast of the United States.

That there are very few, if any, reflector lights on the coasts of the United States better in useful effect than the third order lens light (larger model) erected by the Topographical bureau on Brandywine shoal, while the economy of the lens light is in the ratio of at least 4 to 1.

That the lens lights at Navesink, Sankaty Head, and Brandywine shoal are considered to be, as a general rule, equal to European lights of the same classes.

That the Fresnel lens is greatly superior to any other mode of light-house illumination, and in point of economy is nearly four times as advantageous as the best system of reflectors and Argand lamps.

That the buoys in the waters of the United States are defective in size, shape, and distinction, as a general rule, and that sufficient care is not taken, nor competent persons employed, to place, moor, and replace them.

That the moorings of buoys are not sufficiently heavy, and the chains not properly tested as to size and strength.

That the sea-coast lights along the southern coast from the highlands of Navesink are comparatively useless to the mariner for want of sufficient power and range.

That the dangerous obstructions to navigation around Cape Florida, from the Gulf of Mexico, are not properly lighted and otherwise marked to aid navigators.

That the entire southern coast of the United States requires additional lights and other aids to navigation to render human life and property safe.

That, for want of an efficient organization, there is no systematic plan adopted on any part of the coast of the United States for rendering navigation safe and easy by means of lights, beacons, buoys, &c.

That lights and other aids to navigation are provided, as a general rule, through the action of Congress upon petitions emanating from persons having a local interest, or from boards of pilots, insurance offices, chambers of commerce, &c.

That under a proper organization the officers of the light-house establishment would collect information from reliable sources, decide upon the doubtful points, and recommend to Congress all cases of sufficient importance to warrant appropriations.

That the approaches to some of our principal and most important harbors, bays, &c., are not sufficiently lighted and marked to render steam navigation as rapid, easy, and safe, as the wants of commerce demand, especially to New York, Delaware, and Chesapeake bays, and some of their tributaries.

That the duty of lighting and marking with beacons, buoys, and sea-marks, our extended sea, lake, gulf, bay, sound, and river coast, efficiently and economically, can only be performed by persons of professional experience and undoubted ability upon a systematic plan, based upon the principles of the most approved light-house engineering.

That there is no efficient system of inspection and superintendence of lights in the United States.

That the light-keepers, in many cases, are not competent, and in no instances have they been instructed in reference to their duties, nor examined to ascertain their ability to perform the duties faithfully.

That the supplies of oil, chimneys, wicks, &c., are not tested and selected with sufficient care, or by competent or faithful agents.

That there is no proper system of distributing the supplies to light-keepers.

That proper attention is not given to purchasing and distributing supplies.

That the cleaning powder used in our light-houses is injurious to the reflectors, and not such as is used in other light-house establishments; and other articles are equally defective.

That there is no system in the management of the light-house establishment of the United States.

That the instructions to light-keepers to light, trim, and extinguish the lights at certain specified times are not enforced, to the detriment of the service, and to the imminent risk of endangering vessels in their vicinity.

That such knowledge is not imparted to light-keepers, as a general rule, to enable them to keep their lamps, burners, reflectors, and lanterns in such order as to ensure the best lights from the existing apparatus.

That frequent and rigid inspection and superintendence by competent persons are necessary to ensure an efficient and economical light-house service.

That competent keepers, responsible to the government through inspectors, are indispensable to ensure good lights at all times.

That supplies are not delivered at sufficiently short intervals of time to the lights.

That the present mode of repairing illuminating apparatus, oil tanks, &c., is not economical, efficient, or reliable.

That the removal and replacing of light vesssls, the extinguishment or lighting of lights, removal or placing of buoys, &c., or in any manner changing lights and other aids to navigation, without giving ample notices, are subjects of grave complaints.

That there is no good reason why the light vessels on the coasts of the United States (if properly constructed and moored) should not remain at their moorings under as unfavorable circumstances as those on the coasts of England and Ireland.

That whenever light vessels are reported to have parted their moorings, the circumstances attending them should be carefully investigated by competent and disinterested persons, and the result made known.

That the erection of light-house towers of a uniform height, without regard to the elevation of the land upon which they are placed, is contrary to the first principles of light-house engineering, involving, in situations of great natural elevations above the level of the sea, unnecessary expense, and on low coasts the inefficiency of the light for want of sufficient range.

That due regard has not been had to the wants of commerce selecting sites for lights along the coasts of the United States.

That for want of a proper system in this branch of the public service, the densely populated coasts have a superabundance of lights, to the injury of navigation, while on the sparsely settled coasts, bounding the great outlet to the millions of commerce from the valley of the Mississippi and its tributaries for hundreds of miles, there is not a single light.

That light-house construction, illumination, inspection, and superintendence, involve a large amount of special and general professional knowledge of a high character, and therefore should only be intrusted to the most competent professional persons.

That competent engineers have not been employed, except in a few instances, to plan and superintend the construction and fitting up of the light-houses of the United States.

That the large amounts required annually to repair and keep in good order the towers, buildings, vessels, and illuminating apparatus of the lights in the United States, is attributable to the manner in which the work was executed, and to the inferiority of the materials employed.

That large sums are now required to preserve foundations of light-towers, sea-walls, &c., which might have been saved by the adoption, by competent engineers, of proper plans and foundations for them.

That no systematical and economical plan of construction has been employed in the light-house establishment.

That changes are constantly taking place in the aids to navigation, without any official notice being given to the public of them, which are calculated to mislead mariners.

That there is no proper system of beaconage and buoyage, nor any list of them, by which the navigator, who is not familiar with the coast, can derive any benefit.

That the list of light-houses and light-vessels is defective in many respects; and it, at present, affords very little information to the navigator, and is, in some respects, erroneous.

That there is no regular systematic or effective mode of giving notice to mariners of proposed changes in lights, &c., or of any that may have been destroyed or removed by the action of the sea or winds.

That the buoys are not properly painted according to law, nor are they in other respects properly distinguished one from another.

That light-houses and light-vessels are not sufficiently well distinguished by day.

That the buoys are not properly placed, nor replaced when driven from their positions, and without delay.

That buoys are not placed upon new shoals, over wrecks, &c., except by a special act of Congress, through the agency of some philanthropic or interested person.

That spare buoys are essential for all harbors and rivers in sufficient numbers to allow for all casualities, and for cleaning, painting, &c.

That there is no code or manual of instruction to guide light keepers and others connected with the light-house service, in the performance of their duties in this country, as is found in every well regulated light-house establishment elsewhere.

That there is no meteorological reason for the lights of the United States being worse than those of equal class and importance in England and France.

That there are no proper books of daily expenditure kept; no returns of daily expenditure made of a reliable character; and the lights are deficient in all the essentials for the faithful performance of this duty, such as books, forms, registers, &c.

That light keepers should be required to devote all their time to the care of the lights under their charge, and should not be allowed to attend to their ordinary affairs to the injury of the service.

That if all our present lights were fitted with lens apparatus of equal power to the reflectors now in use, the annual expense for supplies of oil and cleaning materials would cost little more than one-fourth as much as is now expended for these articles of supply annually; that is, that the supplies now costing upwards of \$152,000, would not exceed \$38,000 to \$42,000, making an annual saving of \$110,000 to \$115,000.

That in addition to the greater superiority in brilliancy, power, and economy of the lenses compared to the reflectors, they possess the great advantage of durability, to the extent of never requiring to be renewed.

The board, therefore, recommend:

That the general programme for improving the sea-coast lights of the United States, and of making necessary additions, be adopted as the basis of future recommendation and legislation.

That the Fresnel, or lens system modified in special cases by the holophotal apparatus of Mr. Thomas Stevenson, be adopted as the illuminating apparatus for the lights of the United States, to embrace all new lights now or hereafter authorized, and all lights requiring to be renovated either by reason of deficient power or of defective apparatus.

That the board respectfully recommend to the honorable Secretary of the Treasury, to direct that pending the future action of Congress on the subject of light-house improvements, the 7th section of the act making appropriations for light-houses, light-boats, buoys, &c., approved March 3d, 1851, in the following words:

SEC. 7. *And be it further enacted*, "That hereafter in all new light-houses, in all light-houses requiring new lighting apparatus, and in all light-houses as yet unsupplied with illuminating apparatus, the lens, or Fresnel system, shall be adopted, if in the opinion of the Secretary of the Treasury, the public interest will be subserved thereby," be strictly carried out, and that the necessary illuminating apparatus to fit up the light-houses now authorized to be built shall be of the lens system.

That a rigid and frequent inspection and superintendence by competent persons is essential to an efficient light-house establishment, and the board, therefore, recommend the appointment from the Army and Navy of a suitable number of inspectors for the lights and their accessories, throughout the United States.

That the present light-house establishment requires a thorough organization to ensure to the service, efficiency, and economy, and therefore the board recommend the organization of a light-house board, to be composed of Scientific Civilians, Army and Navy officers, to be charged, by law, with the entire management of the light-house establishment of the United States.

That all sea-coast and other 1st class lights should have not less than two keepers, including all 1st and 2d order lens lights.

That all constructions, renovations, and repairs of towers and buildings, be hereafter made upon the plans, estimates, and drawings, and under the personal superintendence of an officer of engineers of the Army, in conformity to the 9th section of the act making appropriations for light-houses, light-boats, buoys, &c.; approved March 3, 1851.

That the lanterns, and all apparatus for illumination, ventilation, &c., be constructed under the personal superintendence of an officer of engineers of the army.

That the sea-coast lights be increased in power and range.

That all light-vessels not yet fitted with illuminating apparatus requiring to be renovated, and all that may hereafter be authorized by law, be fitted with the best system of lamps and parabolic reflectors, both for fixed and revolving lights.

That more attention be given to the subject of models for light-vessels, constructing and mooring them so as to give greater assurance to the navigator, that they will be always found in position.

That light-vessels be painted and fitted with distinguishing marks by day to enable the mariner to know them without difficulty.

That there be a uniformity in painting, marking, and distinguishing beacons; and that no one be allowed to change the color or distinguishing marks of any beacon, sea mark, or light-house, without authority from the proper office at Washington, and after ample notice shall have been given through the medium of the commercial papers of greatest circulation, and by placards distributed at the different custom-houses, both at home and abroad, and among consuls and commercial agents of maritime nations.

That the buoys be made in size to subserve their proposed purpose, and that different shapes be employed for different channels, dangers, &c.

That competent professional men be required to make frequent inspections of the lights and other aids to navigation along the entire coast.

That supplies of all kinds undergo a most rigid test and scrutiny by a professional person of high moral and social standing, before issuing them to light-keepers.

That light-keepers undergo an examination before being placed in charge of any light, and that they be instructed by a competent person upon the detail of all the duties confided to them.

That instructions, rules, and regulations, embracing every point of duty, be drawn up in clear, plain, and explicit terms, suited to the capacities of the persons for whose benefit they are prepared, and distributed to the light-keepers and others connected with the service; that the general rules and regulations be printed in large type, with conspicuous headings, and framed, so that the keepers may always have access to them; and those more in detail to be well bound, and the keepers required to transfer them to their successors should they leave the lights.

That frequent and rigid inspections of lights by districts be made by competent professional men, and that they make regular returns to the head of the light-house department.

That the keepers be required to keep meteorological and tidal registers in addition to the necessary returns of the daily consumption of oil and other supplies.

That no light-house keeper be appointed who cannot read and write, and is not in other respects competent to the faithful discharge of the duties.

That a mode of supplying persons employed at lights on rocks or other isolated points, on board of light vessels, &c., with rations, to enable them to devote their entire time and attention to the duties, should be adopted.

That light-keepers be required to devote their entire time and attention to their duties on pain of dismissal, and in no case should a keeper be allowed to follow any other vocation to the neglect of the light.

That no keeper be allowed to be absent from the light without a positive written permission from the district inspector.

That no one but a regularly appointed keeper, and his assistant or assistants, be permitted to attend to the apparatus, lighting, &c., of a light-house or light-vessel.

That the best cleaning powders, rags, &c., trimming scissors, and other necessary articles for keeping good lights, be furnished to the keepers; and that they be instructed that, under no pretext, should they employ any other means for keeping their apparatus in good order than those pointed out in the printed instructions from the Department.

That proper curtains be provided for the apparatus of each light-house, &c.

That light vessels never be removed from their stations for repair without first placing a substitute; and in the event of a light vessel parting her moorings, then that position be occupied without delay by a substitute.

That proper lists for the supply of each class of light-house, according to order or number of lamps, be made, and the person charged with the delivery of supplies be guided by it alone, without any discretionary power to increase, lessen, or change the quantity of articles to be on hand on a certain day.

That all the articles of supplies be selected and tested by persons of professional ability and standing.

That the necessary steps be taken, without delay, to ascertain what additional aids to navigation are necessary in the bays of New York, Delaware, and Chesapeake, and their tributaries, to enable steamers and other vessels to enter them at night, and proceed direct to their destination.

That hereafter buoys, required to be placed over newly discovered shoals, or over vessels wrecked in or near channels, or where they may endanger vessels, be placed without delay, and the expense be defrayed from the general appropriations for buoys.

That larger and better distinguished buoys be placed to mark the channels of our principal bays and harbors, especially New York bar and bay, Delaware and Chesapeake bays, &c.

That appropriations be asked for two first-class light vessels, to be fitted up in the best manner with the most approved reflector or refractor apparatus, and with proper distinguishing characteristics; one for the South shoals off Nantucket, and the other for Frying-Pan shoals, off Cape Fear, to be placed in the best positions for aiding navigators, under the direction of the Superintendent of the Coast Survey.

That appropriations be asked for renovating, and for first order lens apparatus for the lights at Cape Hatteras, North Carolina; Cape Florida, Florida; Dry Tortugas, Florida; Cape Canaveral, Florida; Cape Romain, South Carolina; Fire-Island inlet, New York; Cape Henlopen, Delaware; Cape Henry, Virginia; Gay Head, Massachusetts; Montauk Point, New York; and for the following new lights, to be fitted with first order lenses, viz.: one, half way between Montauk Point and Fire-Island light-house, Long Island; and one between Jupiter inlet and Gilbert's bar, Florida.

That the appropriation for Flynn's Knoll light-house be changed to authorize range beacons for New York harbor.

That an appropriation be asked for a bell beacon for Flynn's Knoll.

That, as the foregoing recommendations can only be thoroughly carried out under the orders of a properly organized bureau or board, and as it is of vital importance to the interests of commerce and navigation, and of great importance in an economical point of view, that the present light-house establishment should be improved as rapidly as possible:

To carry out these suggestions, it is further recommended:

That a light-house board be created, by authority of law, to be attached to the Treasury Department, with power to provide rules and regulations for their meetings and proceedings, and for discharging, under the superintendence of the Secretary of the Treasury, all the duties appertaining to the management, maintenance, repair, renovation, illumination, inspection, superintendence, and construction of light-houses, light-vessels, beacons, buoys, and their appendages, in the United States.

That the Secretary of the Treasury, as ex-officio president, with two officers of the Navy of high rank; one officer of the Corps of Engineers of the Army; one officer of the Corps of Topographical Engineers of the Army, and two Civilians, of high scientific attainments, whose services may be at the disposal of the President, as members; and an officer of the Navy, and an officer of Engineers of the Army, as secretaries, shall constitute the light-house board of the United States.

That the light-house board be authorized to appoint their chairman, to preside during the absence of the president, and perform such other duties as may be required by their rules and regulations.

That the light-house board be authorized to prepare such rules and regulations as shall be necessary for securing an efficient, uniform, and economical system of light-house administration, and for securing responsibility in the inspectors, keepers, and others connected with the light-house service, subject to the approval of the Secretary of the Treasury, and which, when approved, shall be respected and obeyed, until altered or revoked by the same authority.

That the light-house board be required to meet four times a year, and subject to be convened by the Secretary of the Treasury, whenever, in his judgment, it may be necessary for the transaction of general or special business, a majority of whom shall constitute a quorum.

That such clerks as are now employed on light-house duties in the Treasury Department may be transferred to the light-house board without any increase of salaries; that the necessary accommodations for the clerks, secretaries, for the preservation of the archives, drawings, &c., and for holding the meetings of the board, be provided in the Treasury Department.

That all archives, books, drawings, models, &c., belonging to the light-house establishment, may be transferred to the light-house board, for their use, in the discharge of their duties.

That the President be authorized and required to appoint from the Army or Navy an inspector of lights, beacons, buoys, &c., for each light-house district, to be arranged by the board, with the approval of the Secretary of the Treasury; which inspectors shall be under the orders of the light-house board.

That the light-house board be authorized to prepare and distribute among the light-house keepers, inspectors, and others connected with the light-house establishment, such rules, regulations, and instructions, as may be necessary to secure an efficient, uniform, and economical system of administering the light-house establishment of the United States, and to secure responsibility from them.

That the light-house board be authorized and required to cause to be prepared by the Engineer-secretary of the Board, or by such officer of Engineers of the Army, as may be detailed for that service, all plans, drawings, specifications, and estimates of cost, of all illuminating, and other apparatus, and of construction and repair of towers and buildings, &c., connected with the light-house establishment; no bids or contract being accepted or entered into, except upon the decision of the Board, at a regular or special meeting, and through their properly authorized officer.

That, hereafter, all materials for the construction and repair of light-houses, light-vessels, beacons, buoys, &c., shall be procured by public contracts, under such regulations as the Board may from time to time adopt, subject to the approval of the Secretary of the Treasury, and all works of construction, renovation, and repair, shall be made by the orders of the Board, under the immediate superintendence of their Engineer-secretary, or of such Engineer of the Army as may be detailed for that service.

That it shall be the duty of the light-house Board to furnish, upon the requisition of the Secretary of the Treasury, all the estimates of expense which the several branches of the light-house service may require, and such other information as may be required, to be laid before Congress at the commencement of each session.

That all acts and parts of acts, inconsistent with these recommendations, be repealed; and all acts and parts of acts relating to the light-house establishment of the United States, not inconsistent with these recommendations, and neccessary to enable the light-house board, under the superintendence of the Secretary of the Treasuary, to perform all duties relating to the management, construction, illumination, inspection, and superintendence of light-houses, light-vessels, beacons, buoys, sea-marks, and their accessories, including the procuring and testing of apparatus, supplies, and materials of all kinds for illuminating, building, and rebuilding when necessary, maintaining, and keeping in good repair the light-houses, light-vessels, buoys, beacons, and sea-marks of the United States; and the second and third sections of the act making appropriations for light-houses, light-vessels, beacons, buoys, &c., approved March 3, 1851, be declared to be in full force, and have the same effect as though the light-house board had not been created.

That no additional salary be allowed to any civil, military, or naval officer who shall be employed on the light-house board, or who may be in any manner attached to the light-house service of the United States; and that it shall be unlawful for any member of the light-house board, inspector, light-keeper, or other person in any manner connected with the light-house service, to be engaged, either directly or indirectly, in any contract for labor, materials, or supplies for the light-house service, or to possess, either as principle or agent, any pecuniary interest in any patent, plan, or mode of construction or illumination, or in any article of supply for the light-house service.

With such a board for the care and management of our present large and daily increasing light-house establishment, composed of the best adapted materials, from civil, military, and naval life, our lights must not only rapidly improve in efficiency, but also in economy.

By the assistance of the officers, proposed as inspectors, and the two secretaries of the board, a general and systematic plan of classification, distinction, illumination, construction, repair, inspection, and superintendence will, in a short time, be introduced, to the great advantage of commerce and navigation, and to the economy of the service.

The engineer-secretary, with the assistance of officers of engineers now authorized by law to superintend the construction and renovation of light-houses, &c., will be able to prepare plans, estimates, and specifications of proposed works of construction and repair, and give a general superintendence to the lights, beacons, and buoys along the entire coast. The board will be able, at the close of the first fiscal year after it is in operation, to make detailed returns of expense of apparatus, combustibles, &c., exhibiting at one view the actual annual expense of every light on the entire coast; examine into the best modes of construction for special positions, make necessary experiments upon apparatus, oils, gases, &c., for light-house purposes; and determine, from information derived from their own and other competent officers, what increased aids are necessary along the coast to recommend to Congress.

They would in a short time be able to furnish to navigators clear and full descriptive lists of the lights, beacons, buoys, sea-marks, &c., with such notices of them as may be necessary to guide them in making our coast in tempestuous weather, and which could be reprinted at short intervals of time, if necessary, to point out new structures or changes.

The Coast Survey charts would then be furnished with an account of every change of position or character of lights, buoys, beacons, &c., which would enhance their present great value to the navigating community.

Under an efficient organization, such as the one proposed, the duty would be performed better and more economically than at present, and there would be great saving in the end, by affording to Congress estimates for proposed new works, rejecting works not considered necessary, and by introducing a class of structures which would require much less annual expense for repair than those now existing.

The ablest Engineers of the Army would be called upon to decide upon plans for structures in cases involving doubts; the best and most durable illuminating apparatus would either be imported or fabricated in this country under the immediate eye of the officers of the board, and, when ready, be placed properly in the lanterns by the engineer charged with the work.

Boards for the execution of important duties are not novelties even in this country. Some, and indeed nearly all, of the most important undertakings which this government has ever embarked in, have been planned and executed under the general supervision and management of boards.

They are found in nearly every branch of our civil and military institutions, of every name, and for almost every purpose. They have been successfully tried for this special purpose in France, where the Savans of the Academy of Sciences, without fee or reward, sit side by side with the Minister of State, the officer of the Navy, and the Engineer; in England, the Duke of Wellington presides, while the Prince, the Peer, the Admiral, the Commoner, and the retired Sea-captain, sit together and devise means for alleviating the hardships and lessening the dangers of the mariner in approaching their dangerous coast.

In Scotland this important branch of service is under the management of a board composed of the sheriffs of the counties, lawyers, and other civilians, who meet four times a year, without any remuneration, to transact business connected with the lights of Scotland.

In addition to these meetings there are numerous standing committees; some of which meet as often as once a fortnight for the transaction of business, which is reported to the general meetings for their sanction and approval. There is attached to this board a secretary and an engineer, who is the executive officer, upon whom devolves all the scientific details of construction, repairs, and illumination.

In Ireland there is also a board charged with the management of light-houses, &c., with a secretary, engineer, &c.

This board, as in Scotland, is composed chiefly of philanthropic Civilians and an English Admiral. The fact of Scotland and Ireland, having no army or navy, and no distinct commercial marine, will readily account for such an organization, in which no motive, other than the praiseworthy one of doing good, could prompt individuals of standing, wealth, and distinction to perform the drudgery of so laborious an office without pecuniary remuneration.

There is not a harbor in England, of any note, that has not its "Trinity board," or "Board of trustees," charged with the lights, beacons, and buoys; such, for example, as Liverpool, Newcastle-upon-Tyne, Hull, &c., under all of which the lights are managed in a manner worthy of the highest commendation, both for efficiency and economy.—(Vide letter of Wm. Lord, Esq., surveyor of the port of Liverpool, and returns of local corporations, appendix.)

It is thus seen that the best managed lights of Europe are under the management and direction of boards with proper officers to assist them in their duties. That this service should be deemed sufficiently honorable in France, Scotland, &c., to be performed gratuitously, is not so much to be wondered at, when we recollect the high standard of excellence it has reached through the instrumentality of the philanthropic individuals constituting those light-house boards.

In concluding this part of their report, the board consider it their duty to urge upon Congress the necessity for a change in the present management of our light-house establishment.

In investigating the subjects confided to them, they have endeavored to reach the truth from observation and research. That they have not done injustice to any one they feel perfectly conscious; to have passed over palpable defects in the present management of our lights, involving great loss of human life and property, without pointing them out, would have been culpable and unpardonable; and that they have looked as leniently as possible on many points considered exceptionable, it is believed will be clearly shown by their report.

The board have not sought so much to discover defects and point them out, as to show the necessity for a better system. Commerce and navigation, in which every citizen of this nation is interested, either directly or indirectly, claim it; the weather-beaten sailor asks it, and humanity demands it.

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Art. XXIX.—*Description of a New Species of Libythea and of Macroglossa;* by J. P. Kirtland.

Libythea bachmanii.

Generic Character.—Inferior palpi projecting, in the form of a beak.

Specific Characters.—Body dark brown, upper surface of the superior wings brownish; with three white spots placed in a triangle, near the tip of the fore wings—the superior and interior spot oblong and irregular, the exterior, the smallest and oval, the inferior, quadrangular. An ochery-yellow band is situated on the humerus and a second upon the posterior margin, but does not reach the tip of the wing. A similar band extends across the lower half of the inferior wings.

Under surface of superior wings similar to the upper—of the inferior, reticulated with brown. The alar extent $1\frac{5}{8}$ inch—while that of the *L. motya* is more than two inches. The form and size of the white spots on the superior wings differ in the two. The absence of a large white quadrangular spot and a different arrangement of the yellow bars mark this as a new species.

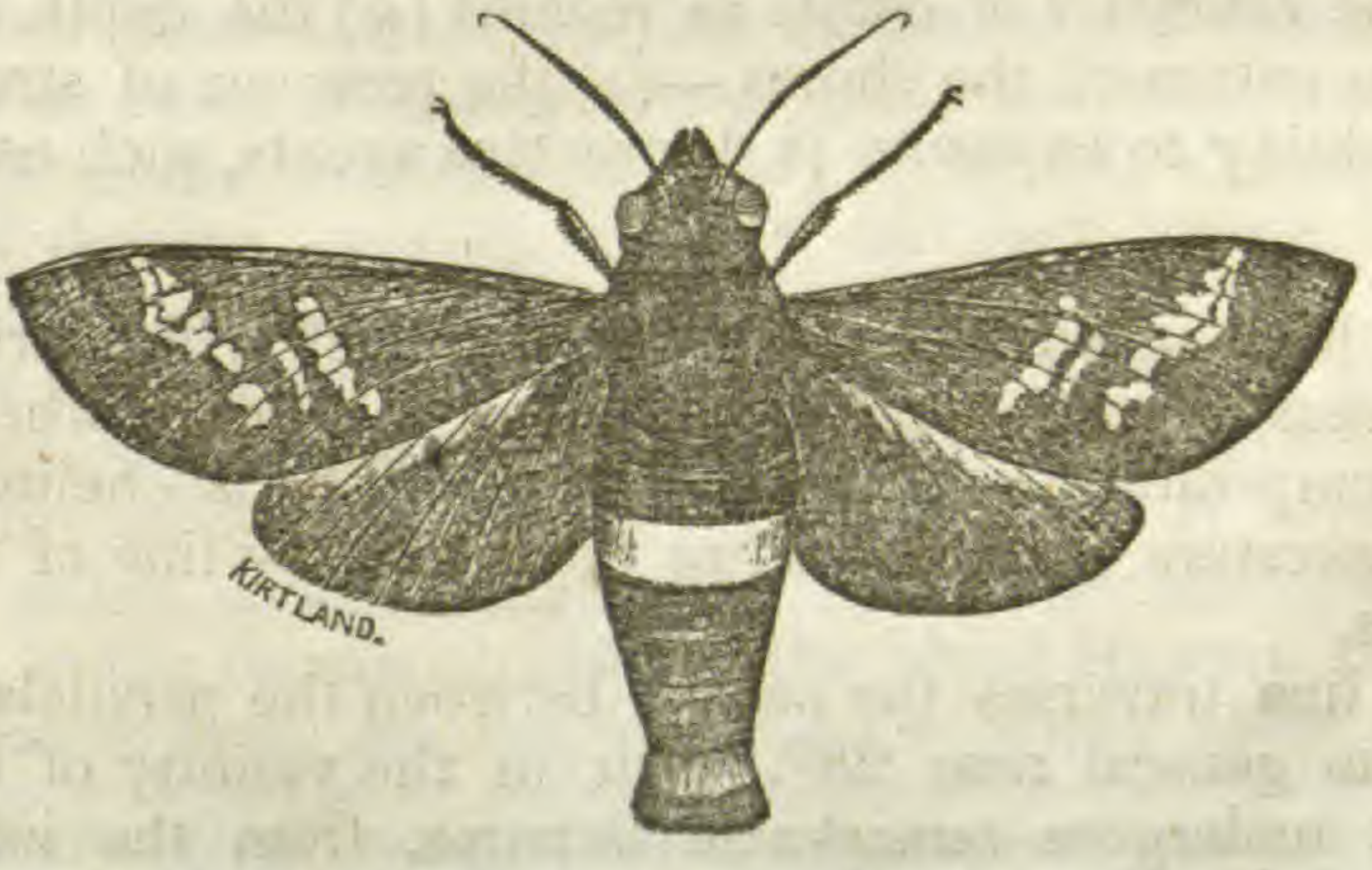
A specimen was captured in Northern Ohio several years since—probably the only one ever observed in this section of the country. The Rev. J. Bachman on examining this specimen in my cabinet, informs me that he once took a similar one in his garden in Charleston, S. C., and sent a description with a drawing of it to Germany, but is not aware of its having been published.

The propriety of designating it by the above specific name, is apparent to every naturalist.

Macroglossa balteata.

Generic Characters.—Antennæ, gradually thickening nearly to the apex, which is scarcely attenuated; simple in the females. Palpi contiguous above the maxillæ, thickly clothed with scales: maxilla as long as the body; body elongate, clothed with scales tufted on the sides towards the apex and at the tip; wings elongate lanceolate, opaque. Larva elongate, slightly attenuated in front; caudal horn straight; pupa elongate, head case produced.

Specific Characters.—Anterior wings reddish brown, with two irregular, oblique white bands, one across the middle, the other half way between it and the tip, composed of lunate segments



intervening between the nervures—the inner band somewhat geminate. Posterior wings, darker brown, anterior edges margined with a few whitish scales. Head and abdomen brown except the fith segment, which is silvery white. Thorax greenish yellow. Tail yellowish, margined with brown. Antennæ, brown, attenuated, terminal hook small and acute. Legs, under surface of the head and thorax white, under surface of the abdomen steel-gray, and of the tail yellowish green. Length $1\frac{1}{10}$ inch. Alar expansion $2\frac{6}{10}$ inches.

Several specimens were taken at Poland, Mahoning Co., Ohio, eighteen years since; one only has been preserved in my cabinet, and is somewhat impaired by fading and mutilation. Still, it is sufficiently perfect to allow of correct description.

The perfect insects were observed flying at midday, and resembled in their habits the lady birds (Sesia), from which they differ in having opaque wings.

Dr. Harris did not embrace this species in his valuable descriptive list of Sphinges of the United States, in the 36th volume of the Journal of Science, and he informs us that it has not been described but resembles somewhat the *M. zonata* of the West Indies, but is larger and differently marked, especially upon the anterior wings. It will occupy a place in his arrangement immediately before the genus Sesia under the family Macroglossiadæ.

ART. XXX.—*On Coral Reefs and Islands;* by JAMES D. DANA. Part Seventh.

5. *Geographical Distribution of Coral Reefs and Islands.*

THE distribution of coral reefs over the globe depends on the following circumstances, arising from the habitudes of polyps already explained:

1. The temperature of the ocean.

2. The character of coasts as regards (*a*) the depth of water,—(*b*) the nature of the shores,—(*c*) the presence of streams.

3. Liability to exposure to destructive agents, such as volcanic heat.

It has been stated that reef-growing corals* will flourish in the hottest seas of the equator, and over the ocean wherever the winter temperature is not below 66° F. The isocheimal line of this temperature therefore forms the boundary line of the coral-reef seas.

This line traverses the oceans between the parallels 26° and 30°, or in general near 28°. But in the vicinity of the continents it undergoes remarkable flexures, from the influence of oceanic currents, the polar currents bending it towards the equator, while the tropical cause a divergence. From a comparison

* There are corals in colder seas; we here refer to those species that form reefs.

of the thermometrical observations of various voyagers with those of the Expedition, I have been enabled to draw this coral boundary with a considerable degree of accuracy; and it is laid down upon the chart of the world accompanying my Report. In the Pacific it is observed to exclude the Galapagos,* and reach the South American coast *north* of the equator, instead of at the parallel of 28° south, the position in mid-ocean. On the coast of Asia it curves *from* the equator beyond latitude 30°. In the Atlantic it forms an abrupt bend far to the north, in the line of the Gulf Stream, and includes the Bermudas in latitude 32° N.; while on the African coast the northern line curves downward to the latitude of the Cape Verds, and the southern upward nearly to the equator. The following table will give more definitely the position of the coral boundary line where it meets the coasts of the continents.

	Pacific Ocean.	Atlantic Ocean.
East side of ocean—Northern,	Latitude 21° N.	Latitude 10° N.
Southern.	4° N.	5° S.
West side of ocean—Northern.	34° N.	34° N.
Southern.	30° S., New Holland. 29° S., Africa.	22° S.

It follows from the above, that while the coral-reef seas are about fifty-six degrees wide in mid-ocean, they are *in the Pacific* seventeen degrees wide on the west coast of America, and sixty-four degrees on the Asiatic side. *In the Atlantic*, they are about fifteen degrees wide on the African coast, and fifty-six degrees on the coast of America. If we reckon to the extremity of the bend in the Gulf Stream, the whole width off the east coast of America, north of the equator, will be over forty degrees. It is obvious that these facts enable us to explain many seeming anomalies in the distribution of coral reefs.

Within the limits included by the coral-reef boundary line, those other causes operate which influence the distribution of reefs. The effect of a deep abrupt coast has been pointed out. The unfavorable character of sandy or muddy shores, and the action of detritus, marine currents, and fresh waters have also been stated.

No less striking are the effects of *volcanic action* in preventing the formation of reefs; and instances of this influence are numerous throughout the Pacific. The existence of narrow reefs, or their entire absence, may often be thus accounted for. For example, in the Sandwich Group, the island Hawaii, still active with volcanic fires, has but few traces of corals about it, while

* Captain Fitzroy, R.N., found the surface temperature of the sea at the Galapagos, from Sept. 16 to Oct. 18, 1835, 62° to 70° F. Oct. 23, in lat. 0° 30′ S., and long. 99° 4′ W., the temperature of the sea was 66° F. Oct. 24, lat. 0° 23′ N., long. 96° 53′ W., temp. 70½°, 71½° F. While under the equator, about the middle of the Pacific, the range of surface temperature of the sea through the year is 81° to 88° F.

the westernmost islands, which have been longest free from such action, have reefs of considerable extent. The island of Maui exemplifies well the general fact. The island consists of two peninsulas: one, the eastern, recent volcanic, with a large crater at summit, and the other, the western, presenting every evidence in its gorges and peaks and absence of volcanic cones, of having become extinct ages since. In conformity with the view expressed, the coral reefs are confined almost exclusively to the latter peninsula. Other examples are afforded by the Samoan Islands. Savaii abounds in extinct craters and lava streams, and much resembles Hawaii in character: it bears proof in every part of being the last seat of the volcanic fires of Samoa. Its reefs are consequently few and small: there is but a narrow line on part of the northern shores, although on the other islands they are very extensive. The absence of corals results obviously from the destruction of zoophytes by heat, consequent on volcanic action. Submarine eruptions, which are frequent as long as a volcano near the sea is in action, heat the waters, and destroy whatever of life they may contain: after the eruption of Kilauea, in 1840, there were numerous dead fish thrown on the beach; and many such instances in different regions are on record. Other facts, illustrating the effects of volcanic heat in preventing the growth of reefs, will be brought forward in the following pages.

The agencies affecting the growth of coral reefs being before the mind, we may proceed to notice the actual distribution of reefs through the coral seas. The review given is a rapid one, as our present object is simply to explain the absence or presence of reefs within the coral reef limits, by reference to the above facts.*

Pacific Ocean.—The west coast of South America is known to be without coral reefs even immediately beneath the equator; and the seas of the Galapagos also grow no coral. The northward deflection of the coral boundary line, as shown, accounts for their absence. In the harbor of Callao (the seaport of Lima), the temperature is sometimes down to 59° or 60° F., and at the Galapagos, Captain Fitzroy found the waters in September to fall often to 62° F., and once to 58½ F. This month, it should be observed, cannot be the coldest of the year. In the bay of Panama, coral is reported to occur, but there are no reefs.†

* In the valuable work by Mr. Darwin, the geographical distribution of reefs is treated of at length in the Appendix, pp. 151–205. The facts here detailed have been obtained from independent sources, except where otherwise acknowledged. In accounting for the character and distribution of reefs, Mr. Darwin has erred in attributing too much weight to a supposed difference in the amount of subsidence in different regions, neglecting to allow the requisite limiting influence to volcanic agency, and to the other causes mentioned.

† Jour. Roy. Geog. Soc., i, 69, on the Isthmus of Panama, by J. A. Lloyd.

The coast to the north, as far as latitude 21° N., is within the warm limits, but without reefs. In Captain Colnett's voyage, allusion is made to a beach of coral sand on one of the Revillagigedo Islands, in latitude 18°; beside this statement, I have met with no allusion to corals on any of the islands off the Mexican coast. The paucity of corals in this region may perhaps be owing, in some degree, to the fact that the tropical currents of the ocean flow *westward* instead of eastward; and, consequently, they prove an obstable to the distribution of polyps to this coast from the islands of the Pacific. Moreover, the cold currents which pass the Galapagos form an impassable barrier between the Paumotus and Mexico.

Between the South American coast and the Paumotus are two rocky islands, Easter or Waihu, and Sala-y-Gomez, both of which are without reefs.*

The Paumotus commence in longitude 130° W., and embrace eighty coral islands, all of which, excepting about eight of small size, contain lagoons. Besides these, there are, near the southern limits of the archipelago, the Gambier Islands, and Pitcairn, of basaltic constitution. The former, in 23° S., have extensive reefs; about the latter, in 25° S., there are some growing corals, but no proper reefs.

The Marquesas, in latitude 10° S., have but little coral about them; and this is the more remarkable, as they are in close proximity to the Paumotus. But their shores are, in general, very abrupt, with deep waters close to the rocks. An island which, before subsidence has commenced, has some extent of shallow waters around, might have very bold shores, after it had half sunk beneath the waves. This would be the case with the island of Tahiti; for its mountain declivities are, in general, singularly precipitous, except at base. The Marquesas may, therefore, have once had barrier reefs, which were sunk from too rapid subsidence; and afterwards, on the cessation of the subsidence, others failed to form again, on account of the deep waters.

The Society Islands have extensive coral reefs, with distant barriers. The reefs of Tahiti extend, in some parts, a mile from the shores. Tethuroa, to the north of Tahiti, and Tubuai, near Bolabola, are lagoon islands. Maitea, east of Tahiti, is a sugarloaf truncated at summit, four miles in compass, and is said by Forster to have an encircling reef.†

South of the Society Islands, near 25° S., is Rapa, which is represented as a collection of rugged peaks without coral shores. The Rurutu and Hervey Islands, just northwest of Rapa, have coral reefs fringing the shores. There is no evidence of recent

* Captain Beechey mentions that at forty-one fathoms, near Sala-y-Gomez, he found a bottom of sand and coral.

† Darwin, op. cit., p. 153.

volcanic action among them. Some of them are elevated coral islands, as Mitiaro, Atiu, Mangaia and Mauki, and also, according to Stutchbury, Rurutu. Okatutaia is a low coral island but six or seven feet out of water.

Between the Paumotus and the longitude of Samoa, are numerous small islands, all of coral origin.

The Samoan Islands have extensive reefs. About Tutuila they are somewhat less extensive than around Upolu, owing to its abrupt shores; and about Savaii they are still smaller, as already explained. The influence of abrupt shores may also be seen in some parts of Upolu; for example, to the west of the harbor of Falifa, where, for several miles, there is no reef, except in some of the indentations of the coast. Manua is described as having only shore reefs.*

The Tonga Islands, south of Samoa, for the most part, abound in coral reefs, and Tongatabu and the Hapai Group are solely of coral. Eoa is a moderately high island, with a narrow reef. Tafoa, an active volcano, and Kao an extinct cone, are *without* reefs. Vavau, according to Williams,† is an elevated coral island. Pylstaarts, near Eoa, is a naked rock, with abrupt shores, and little or no coral. Sunday Island, farther south, (29° 12′ S.,) is beyond the coral-reef limits.

North of Samoa are several scattered islands of small size, all of coral.

The Feejee Group, as we have sufficiently described, abounds in reefs of great extent. There are no active volcanoes, and, where examined, no evidence of very recent volcanic action. The many islands afford a peculiarly favorable region for the growth of zoophytes, and the displays of reefs and living corals were the most remarkable seen by the writer in the Pacific.

North of the Feejees are numerous islands, leading up to the Carolines. They are all of coral, excepting Rotuma, Horne and Wallis's Islands, which are high, and have fringing or barrier reefs. The reefs of Wallis Island are very extensive.

The Tarawan Islands, and the Carolines including the Marshall Islands, eighty-seven in number, are all atolls, excepting the three Carolines, Ascension or Banabe, (Pouynipete of Lutke,) Ualan, and Hogoleu (or Roug).

The westernmost of the Sandwich Islands, Kauai and Oahu, have fringing reefs, while eastern Maui and the island of Hawaii have but few traces of corals. On Hawaii, the only spot of reef seen by us, was a submerged patch off the southern cape of Hilo Bay. We have already attributed the absence of corals to the volcanic character of the island. The small islands to the north-

* Narrative Expl. Exp., by C. Wilkes, U. S. N., ii, 65.
† Miss. Enterprises, p. 427, Amer. ed.

west of Kauai, are represented as coral reefs, excepting the rocks Necker and Bird Island; the line stretches on to 28° 30′ N.,* the northern limit of the coral seas.

The Ladrones, like the Sandwich Group, constitute a line or linear series of islands, one end of which has been long free from volcanic action, while the other has still its smoking cones. While the appearances of recent igneous action increase therefore as we go northward, the extent of the coral reefs increase as we go southward; no reefs occur about the northernmost islands, while they are quite extensive on the shores of Guam. This group consequently, like the Hawaiian and Samoa, illustrates the influence of volcanic action on the distribution of reefs.

A short distance southwest of the Ladrones, and nearly in the same line, lie extensive reefs. Mackenzie's is an atoll of large size. Yap, Hunter, Los Matelotas and the Pelews are high islands, with large reefs. In the last mentioned, the reef-grounds cover at least six times the area occupied by the high land. Still farther south, towards New Zealand, lie the large atolls Aiou, Asie, and Los Guedes.

South of the equator again:—The New Hebrides constitute a long group of high islands, remarkable for the absence of coral reefs of any extent, though situated between two of the most extensive coral regions in the world,—the Feejees and New Caledonia. But the volcanic nature of the group, and the still active fires of two vents in opposite extremities are a sufficient reason for this peculiarity. Tanna is one of the largest volcanoes of the Pacific; and nearly all the islands of the New Hebrides, as far as known, indicate comparatively recent igneous action, in which respect they differ decidedly from the Feejees.

The Vanikoro Group, north of the New Hebrides, according to Quoy, has large barrier reefs about the southernmost island, Vanikoro; but at the northern extremity of the range there is an active volcano Tinakoro, and no coral. Tikopia, to the southeast of Vanikoro, is high and volcanic, according to Quoy, though not now with active fires; and it appears from the descriptions given to have no reefs. Mendana, northeast of Tinakoro, according to Kruesenstern, as stated by Darwin, is low with large reefs; Duff's Islands have bold summits with wide reefs.

New Caledonia and the northeast coast of New Holland, with the intermediate seas, constitute one of the grandest reef regions in the world. On the New Caledonia shores the reefs are of great width, and not only occur along the whole length of the western coast, a distance of 200 miles, but extend to the south beyond the main land 50 miles, and north 150 miles, making in

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* For an account of some of these islands, see Lisiansky's Voyage, 1803–6, in the Neva, 4to., London, 1814, pp. 254, 257; also Hawaiian Spectator, vol. i.

all a line of reef full 400 miles in length. Towards the north extremity, however, it is interrupted or broken into detached reefs. This surprising extent is partly explained by the fact that New Caledonia is not a land of volcanoes; but on the contrary, consists of the older Plutonic or metamorphic rocks, with probably some sedimentary rocks. The streams of so large a land might be expected to exclude reefs from certain parts: and in accordance with this fact, we find the reefs of the windward or rainy side comparatively small, and scarcely indicated on our charts; while on the dry or western side, they often extend 30 miles from the shores. The theory of subsidence accounts fully for the great prolongation of the New Caledonia reefs; they indicate, moreover, the existence of a former land near three times the area of the present island.

Between New Caledonia and the New Hebrides are several high islands, one of which, *Lafu*, has been recently described by Rev. W. B. Clarke as an elevated coral island, with fringing reefs; and it appears also from the remarks of this writer, that the other islets of what is called the Loyalty Group, are of the same kind. Lafu, the largest of the number, is about ninety miles in circumference.*

South of New Caledonia lies Norfolk Island, in latitude 29° S., about which there is said to be some coral, which is occasionally thrown on the beach, but no reefs.

Between Australia and New Caledonia the islands are all of coral. The New Holland reef extends from Torres Straits to the east cape in latitude 24° S., a distance of 1000 nautical miles, though much interrupted along its course. It has been shown how this broken character might result during a subsidence, owing to a change in the abruptness of the land successively becoming the coast line, and also to the variations in the currents, retarding the growth in some places and aiding it in others. These causes might make a broken reef of one that was originally continuous: yet we have no reason to believe that the reef was ever continuous. It will be found, as we proceed, that long reefs on the shores of continents are not common. In this case the zoophytes are not exposed to the destructive agents usual on such shores, as the land is in a dry climate, the shores are mostly rocky, and there are no streams of any extent emptying into the ocean. The east cape is the southern limit, because here the tropical current, owing to the direction of the coast above, trends off to the eastward of south, away from the land, while a polar current follows up the shores from the south as far as this cape. South of this cape there are only a few scattered species of coral zoophytes.

The Louisiade Group is described as a region of extensive reefs.

* Quarterly Journal of the Geological Society, No. 9, p. 61.

The Salomon Islands, as far as ascertained, are but sparingly fringed, except the two westernmost, which are said to have large reefs. The peculiar character of these lands is too imperfectly known to allow of our deducing the cause of so restricted reefs. Off to the north of the Salomon Islands, there are several atolls of considerable size. New Ireland, according to D'Urville, has distant reefs on part of its shores.

The Admiralty Islands, farther west, are enclosed by barrier reefs, and beyond this group there are a few lagoon islands.

The north side of New Guinea is mostly without coral. There are several islands off this coast, which are conical volcanic summits, and one of them, near New Britain, and another (Vulcano), near longitude 145° E., are in action.

From the facts thus far detailed, the connection between the prevalence or extent of reefs, and the various causes assigned as limiting or promoting their growth, is obvious. The amount of subsidence determines in some cases the distance of barrier reefs from shores; but it by no means accounts for the difference in their extent in different parts of a single group of islands. Indeed, if this cause be considered alone, every grade of extent, from no subsidence to the largest amount, might in many instances be proved as having occurred on a single island. Of far greater importance, as has appeared, is the volcanic character of the land. At whatever time the existing reefs in the Pacific commenced their growth, they began about those of the igneous islands whose fires had become nearly or quite extinct; and as others in succession were extinguished, these became in their turn the sites of corals, and reefs began to form. Those lands whose volcanoes still burn, are yet without corals, or there are only limited patches on some favored spots. Zoophytes and volcanoes are the land-making agents of the Pacific. The latter prepare the way by pouring forth the liquid rock, and building up the lofty summit. Quiet succeeds, and then commences the work of the zoophyte beneath the sea, while verdure covers the exposed heights.

We may add a few more illustrations from other parts of the coral-reef seas.

Along the north and northwest coast of New Holland, there appears to be little or no coral in the Gulf of Carpentaria, while some extensive patches occur on the shores west of this Gulf, as far as the northwest cape in latitude 23° S.

In the East Indies, there are large, scattered reef-islands, south of Borneo and Celebes, and the west end of New Guinea. The islands of Timor-laut, and Timor, with many of those intermediate, have large reefs. The Arru Group consists wholly of coral. This sea, from Arru to the islands south of Borneo, is more thriving in corals than any other in the East Indies.

Another East Indian coral reef region, of some extent, is the Sooloo Sea, between Mindanao and the north of Borneo. Yet the reefs are mostly submerged. We saw no wide platforms bordering the high lands, like those of the Pacific. There are, however, some small coral islets in the Balabac Passage.

In other parts of the East Indies, coral reefs are quite inconsiderable. Occasional traces, sometimes amounting to a fringing reef, occur along Luzon and the other Philippines.

We coasted by the west shore of Luzon to Manila, and thence by Luban, Mindoro, Panay, to Caldera, near Samboangan in Mindanao; and through this distance, no reefs were distinguished, as would have been the case had there been any of much extent. At the last mentioned place we found coral pebbles on the beach, and by dredging obtained living specimens in six to eight fathoms of water. The only large reefs were those between Mindoro and the Calaminianes. There are fringing reefs at Singapore. The islands of Borneo, Celebes, Java, and Sumatra, according to all the authorities seen by the writer, have but few coral patches about their shores, although affording long lines of coast for their growth. In the China Seas, there are numerous shoals, banks and island reefs of coral. Moreover, shore-reefs occur about Loochoo, and the islands between it and Formosa. But the whole eastern coast of China appears to be without coral. Quelpaert's island, south of Corea, in 34° N., is described as having coral about it; and this has been confirmed by late information.

Why should the reefs of the East India Archipelago be so limited in extent, and large parts be almost destitute, notwithstanding their situation in the warmest seas of the ocean, and in the most favorable region for tropical productions? We are not prepared for a full answer to this inquiry, which demands a thorough knowledge of the shores, as well as of the currents, and of the former and present condition of volcanic fires. From personal observation, we may reply satisfactorily, as far as regards part of the southern half of the east coast of Sumatra. This coast is low, and sandy or muddy, and thus affords the most unfavorable place for zoophytes. A strong current sweeps through the straits of Banka, which keeps the water muddy, and the shores in constant change. The same cause may operate on the coasts of other islands, but we are ignorant to what extent.

The East Indies have been remarkable for their volcanoes, exceeding, for the area, every other part of the world: and this fact must have influence on the formation of coral reefs, though we have not the data for fixing the extent of the influence. Of the thousand vents which have been in action, several still make themselves felt over wide areas. The Sooloo islands are about one hundred in number, and nearly all are pointed with volcanic cones; and while some have the broken declivities that are marks of age, others have regular slopes, as if but just now extinguished: a dozen of these cones may sometimes be seen on a single island. These volcanic peaks often rise out of the sea, as if their formation had begun with a submarine eruption. In a region so extensively and so recently igneous, the coral polyp would have found little chance to develop itself, until volcanic action had become comparatively quiet, and deluges of hot water ceased. There appears, therefore, to be some reason for the fact that the reefs are small, and have seldom reached the surface.

The Sooloo Sea is but one of the volcanic clusters in these seas. Java, several of the Philippines, and other islands south of these last, with the northern shore of New Guinea, make up a wide region of fires, and it cannot be doubted that the frequent eruptions prevented the growth of coral, for a long period, over large areas. For other causes we must look to the nature of the coasts, fresh-water streams and marine currents; we leave it for other investigators to apply the explanation to particular coasts.

The coast of China probably owes its freedom from corals to its alluvial character and its fresh-water streams.

One interesting fact should be noted:—the most extensive reefs in the East Indies are to be found in the open seas, between the large islands; these islands, at the same time, often being without proper reefs, or with mere traces of coral. This is the case between Borneo and the range of large islands south: the China Sea is another instance of it; north of New Guinea, a few degrees, is another. How far this is due to their being distant from the scenes of igneous action, and from the detritus and fresh-water of island streams, remains to be determined. A sinking island becomes a more and more favorable spot for the growth of coral, as it descends; for as its extent diminishes, its streams of fresh-water and detritus also decrease. It might therefore be expected, on this account alone, that such isolated spots of land, away from all impure waters, in the open ocean, should become the bases of large reefs. The existence of these reef-islands is, therefore, no necessary proof of greater subsidence than the coast adjoining has undergone, though the fact of a greater subsidence is by no means impossible.

In the Indian Ocean, the Asiatic coast is mostly free from growing coral.* The great rivers of the Continent are probably the most efficient cause of their absence, both directly, through their fresh waters, and through the detritus they transport and distribute along the shores. It will be observed that this agent, so ineffectual on small islands, is one of vast influence upon larger lands. Ceylon has some fringing reefs.

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* Mr. Darwin alludes to small patches in the Persian Gulf.

The islands of the Indian Ocean are, to a great extent, purely of coral. Of this character are the Laccadives, Maldives, Keelings, Saya-de-Malha, Almirante, and Cosmoledo. The Chagos shoal is of the same character: and the shoal Cargados is probably similar. The Seychelles are small islands with extensive reefs. We remark here the same fact alluded to above, that reefs abound in the open ocean, though absent from the Continental coasts; and the same reason may apply to both cases.

Madagascar has a fringing reef upon its southwestern point, according to Mr. Darwin, and on some parts of the coast above; also on the north and eastern shores far down as latitude 18° S.* The Comoro Islands, between Madagascar and the continent, have large barrier reefs.

The eastern coast of Africa has narrow reefs extending north with some interruptions from Mozambique, in latitude 16° S., to a short distance from the equator. Corals also abound in the Red Sea, occurring in some parts on both shores, though most frequent on the eastern, from Tor, in the Gulf of Suez, to Konfodah. This long continental reef may at first be deemed a little remarkable, after what we have remarked upon such reefs elsewhere. Yet the surprise is at once set aside by the striking fact that this whole coast, from the isthmus of Suez south, has no rivers, excepting some inconsiderable streams. It affords, therefore, an interesting elucidation of the subject under consideration, and confirms the view taken to account for the absence of reefs from the China and South Asiatic coasts. It is a fact almost universal, that where there are large fresh water streams, there are earthy or sandy shores; and where there are no such streams, rocky shores, though not uniformly occurring, are common.

Passing from the Indian to the Atlantic Ocean, we find little or no coral on the west coast of Africa. The islands of Cape St. Anne and Sherboro, south of Sierra-Leone, are described as coral by Captain Owen, R.N.† But this has been since denied. The island of Ascension, in 7° 56′ S., and 14° 16′ W., must have been formerly bordered by growing coral, as Quoy and Gaymard mention that a bed of coral rock may be seen buried beneath streams of lava. Quoy also states that the corals which formed these reefs are no longer found alive, and adds that volcanic eruptions have probably destroyed them. The cold polar currents along the African coast, although generally leaving about fifteen degrees of latitude within the coral-reef seas, may at times close up and reduce it to still narrower limits. The same obstacle to the diffusion of species eastward, mentioned as occurring in the Pacific—that is, westerly currents—exists also in the Atlantic, and probably with the same effect.

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* Darwin, op. cit., p. 187.

† Journal of the Royal Geographical Society, ii, 89.

On the American shores of the Atlantic there are few reefs, except in the West Indies. The waters of the Orinoco and Amazon, and the alluvial shores they occasion, exclude corals from that part of the coast. But about Pernambuco, as I am informed by Mr. Titian R. Peale, there are some patches of growing corals, and they are said to extend along to 20° or 21° S.

The Bermudas are of coral origin, and are the most northern point of growing reefs.

In the West Indies, the reefs of Key West, Cuba, the Bahamas, and many of the eastern islands are well known. On the east coast of Florida they continue up as far as Cape Florida, in latitude 25° 40′ N.: the west coast is free of them. There are also said to be patches at intervals along the coast of Venezuela and Guatemala; but the west shores of the Gulf of Mexico, as well as the northern, like West Florida, are mostly low, and everywhere without corals. They are within the influence of the Mississippi and other large rivers.

We have thus seen that the earth is belted by a coral zone, corresponding nearly to the tropics in extent, and that the oceans throughout it abound in zoophyte reefs, wherever congenial sites are afforded for their growth. We have found that the currents of extra-tropical seas, which flow westward, and are interrupted and trended *towards* the equator by the continents, contract the coral seas in width, narrowing them to a few degrees on the western coasts of the continents; while the tropical currents, flowing eastward, *diverge* from the equator and cause the belt to widen near the eastern shores. The polar currents flow also by the eastern coasts, preventing the warmer waters from increasing the width of the coral zone as much as it is contracted on the western coasts. Moreover, the trend and capes of the coast produce other modifications in the direction of the currents, the most of which are apparent in the actual distribution of coral reefs. On the shores of the continents we have observed that there are no extensive reefs, except along eastern Africa; and, while other lands abound in rivers, this African coast has only some small streams. Thus the influence of continental waters and detritus on the distribution of reefs, has been shown to be very marked. But about the Pacific islands, where streams are small, the same cause has had little effect, seldom doing more than modifying somewhat the shores and bottom of a harbor. We have ascertained that in different groups, as the Ladrones, the Sandwich Islands, Samoa, New Hebrides, there is an inverse relation between the extent of reefs and the evidences of recent volcanic action in the island; and that the largest reefs exist where there is no proof of former igneous action, or where it has long ceased. The adverse influence of volcanic agency to the planting and increase of coral reefs is thus satisfactorily exhibited. The existence of large reef-islands in open seas, where the neighboring lands are mostly destitute of coral reefs, has farther supported our conclusions, as such islands are in general removed from the deleterious influences just mentioned.

The modifications of form and interruptions of reefs arising from abrupt or sloping shores, and tidal or local currents, have also been exemplified. The origin of the distant barrier has been traced to a sinking of the land which it once simply fringed; and the lagoon island to a continuation of this subsidence till the original land had disappeared.

This account of coral reefs and islands may be closed by a statement or recapitulation of some deductions which have a special bearing upon geology.

Art. XXXI.—*Abstract of Meteorological Observations made at Burlington, Vt., in* 1851; by Z. Thompson.

The location where the following observations were made, is one mile from the shore of Lake Champlain, and 256 feet above the lake (346 above the sea) in lat. 44° 29′, and long. 73° 11′.

1851.	Thermometer.				Barometer.			
Months.	Mean.	Highest.	Lowest.	Range.	Mean.	Highest.	Lowest.	Range.
	°	°	°	°	Inches.	Inches.	Inches.	Inches.
January,	19·60	43	−14	57	29·73	30·53	28·71	1·82
February,	26·02	53	−17	70	29·90	30·60	29·18	1·42
March,	33·35	64	− 2	66	29·74	30·30	29·30	1·00
April,	43·31	62	20	42	29·69	30·40	29·30	1·10
May,	54·13	79	35	44	29·74	30·28	29·05	1·23
June,	62·97	91	47	44	29·64	30·22	29·18	1·04
July,	67·40	88	48	40	29·58	29·84	29·28	0·56
August,	65·68	85	47	38	29·70	29·93	29·40	0·53
September,	60·58	92	35	57	29·83	30·22	29·34	0·88
October,	51·09	78	28	50	29·63	29·98	29·22	0·76
November,	31·74	53	10	43	29·67	30·47	29·00	1·47
December,	18·58	46	−17	63	29·69	30·33	29·07	1·26
Annual mean	44·54			109	29·71			1·89

1851.	Winds.								Weather.		Snow.	Water.
Months.	N.	N.E.	E.	S. E.	S.	S.W.	W.	N.W.	Fair.	Cloudy	Inches.	Inches.
January,	7	2	1	2	11	0	6	2	15	16	11	1·20
February,	5	1	1	1	15	1	1	3	13	15	8	1·90
March,	10	2	1	0	11	0	3	3	20	11	14	0·67
April,	17	1	1	1	5	1	1	3	17	13	0	1·67
May,	11	1	1	0	13	1	2	2	19	12	0	2·29
June,	4	1	2	0	15	3	1	4	14	16	0	7·33
July,	9	1	1	1	13	2	1	3	20	11	0	3·81
August,	12	1	0	0	14	1	2	1	24	7	0	1·92
September,	12	1	0	0	13	1	1	2	23	7	0	2·06
October,	6	0	0	1	18	1	3	2	17	14	0	3·56
November,	6	1	1	3	9	0	3	7	14	16	24	3·59
December,	6	3	1	1	16	0	2	2	18	13	14	1·83
	105	15	10	10	153	11	26	34	214	151	71	31·83

The results in the above tables are deduced from three daily observations made at sunrise, 1 P. M. and 9 P. M. The warmest day in the year was September 10, the mean heat of which was 80°; the coldest day was the 8th of February, the mean of which was −11·5°. The mean temperature of the year was 0°·37 colder than the average of the thirteen preceding years. The range of the thermometer was 2° less and the range of the barometer 0·20 in. greater than in 1850.

The column of water includes the rain and melted snow; and the amount in 1851, was 5·68 inches less than in 1850, and 0·41 in. less than the mean annual fall in the preceding thirteen years. The greatest fall of water in any one of those thirteen years, was in 1847, when it amounted to 38·55 inches, and the smallest was in 1849, amounting only to 26·35 inches.

The fall of snow in 1851 was 37 inches less than in 1850. During the year there were eighty-six days of tolerable sleighing in Burlington and vicinity, two days more than last year. The broad lake opposite to Burlington froze over on the 1st day of February, which was about the usual time of closing, and continued closed till the 12th of March. The water of the lake was highest on the 16th of April, being then two feet below extreme high-water mark, and lowest on the 13th of October, being 7 feet 7½ inches below high water—change of level of the lake in the year 5 feet 7½ inches. The extreme change of level has not been observed to exceed 8 feet.

The greatest rain-storm in 1851, was on the 22d and 23d of June, and the fall of water in those two days was 5·16 inches. The months of November and December were each more than 5° colder than the average of those months, for the thirteen preceding years.

Robins appeared March 20, Bluebirds 22, Cowbirds and Long-Sparrows 26, Meadow Larks and Flycatchers April 6, White bellied Swallows 18, Barn Swallows 25, White Elm in blossom 15, Trailing Arbutus 12, Red Maple 19, Liverleaf and Bloodroot 24, Venus' Pride 28, Gooseberries blossom May 7, Currants 9, Plums and Pears 15, Siberian Crab-apple 21, Common apple 24, ten days earlier than last year.

ART. XXXII.—*Inaugural Lecture, the General Bearing of the Great Exhibition on the Progress of Art and Science;* by WILLIAM WHEWELL, D.D., F.R.S., Master of Trinity.*

IT seems to me as if I were one of the persons who have the least right of any to address an audience like this on the subject of the Great Exhibition of the Art and Industry of All Nations, of which the doors have so lately closed; inasmuch as I have had no connection with that great event, nor relation to it, except that of a mere spectator—one of the many millions there. The eminent and zealous men in whose wide views it originated, by whose indomitable energy and perseverance the great thought of such a spectacle was embodied in a visible, material shape; those who, from our own countries or from foreign lands, supplied it with the treasures and wonders of art; those who, with scrutinizing eye and judicial mind, compared those treasures and those wonders, and stamped their approval on the worthiest; those who can point to the glories of the Exhibition, and say, "*quorum pars magna fui;*"—those persons may well be considered as having a right to express to you the thoughts which have been suggested by the scenes in which they have thus had to live: but of these I am not one. I have been in the Exhibition, as I have said, a mere spectator. Nevertheless, the Council of the Society of Arts have done me the honor to express a wish that I should offer to you such reflections as the spectacle of the Great Exhibition has suggested to me; and in deference to their wishes, and especially as a token of my admiration of the truly royal mind, which saw clearly, in despite of the maxims of antiquity, that there *was* such a royal road to knowledge, I shall venture to offer you a few remarks,—which, precisely on account of the circumstances which I have stated, may be considered as representing the views of an unconnected spectator of the great spectacle.

To write or speak the epilogue after any great and grand drama, is by no means an easy task. We see the confession of the difficulty in the very incongruity of the manner in which the task is sometimes attempted: as, when after the curtain has fallen upon a deep and solemn tragedy, some startling attempt at wit and pleasantry is uttered to the audience,—it may be by one of the characters whose deep sorrows or lofty aims we have been following with profoundest interest. You will, at least, on the present occasion, not have the difficulty of the task shown *in this manner.* Nor, indeed, is it my office, in any sense, to speak an epilogue at all. Perhaps such remarks as I have to make may

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* From the Edinb. Phil. Jour., January, 1852, p. 1.

rather be likened to the criticism which comes after the drama. For, as you know, criticism does come after poetry; the age of criticism after the age of poetry; Aristotle after Sophocles, Longinus after Homer. And the reason of this has been well pointed out in our time:—that words, that human language, appear in the form in which the poet utters them, and works with them for his purposes, before they appear in the form in which the critic must use them: language is picturesque and affecting, first; it is philosophical and critical afterwards:—it is first concrete, then abstract:—it acts first, it analyzes afterwards. And this is the case, not with words only, but also with works. The *poet*, as the Greeks called him, was the *maker*, as our English fathers, also, were wont to call him. And man's power of making may show itself not only in the beautiful *texture* of language, the grand *machinery* of the epic, the sublime display of poetical *imagery;* but in those material works which supply the originals from which are taken the derivative terms which I have just been compelled to use: in the textures of soft wool, or fine linen, or glossy silk, where the fancy disports itself in wreaths of visible flowers; in the machinery mighty as the thunderbolt to rend the oak, or light as the breath of air which carries the flower-dust to its appointed place; in the images which express to the eye beauty and dignity, as the poet's verse does to the mind; so that it is difficult to say whether Homer or Phidias be more truly a poet. That mighty building, then, along the aisles of which we have wandered day after day in past months, full as it was of the works of man, contained also the works of many who were truly makers;—who stamped upon matter, and the combinations of matter, that significance and efficacy which make it a true exponent of the inward activity of man. The objects there, the symbols, instruments, and manifestations of beauty and power, were utterances,—articulate utterances of the human mind, no less than if they had been audible words and melodious sentences. There were expressed in the ranks of that great display many beautiful and many powerful thoughts of gifted men of our own and of other lands. The Crystal Palace was the cabinet in which were contained a vast multitude of compositions—not of words, but of things, which we who wandered along its corridors and galleries might con, day by day, so as to possess ourselves, in some measure, and according to our ability, of their meaning, power, and spirit. And now, that season of the perusal of such a collection of works being past; those days of wonderment at the creations of such a poetry being gone by; the office of reading and enjoying being over; the time for criticism seems to have arrived. We must now consider what it is that we have admired, and why; must try to analyze the works which we have thus gazed upon, and to discover the principles of their excellence. As the critic of literary art endeavors to discern the laws of man's nature by which he can produce that which is beautiful and powerful, operating through the medium of language, so the critic of such art as we have had here presented to us—of *material* art, as we may term it—endeavors to discern the laws of material nature; to learn how man can act by these, operating through the medium of matter, and thus produce beauty, utility, and power. This kind of criticism appears to be the natural and proper sequel to such a great burst of production and exhibition as we have had to witness; to discover what the laws of operative power are, after having had so great a manifestation of what they do.

To discover the laws of operative power in literary works, though it claims no small respect under the name of criticism, is not commonly considered the work of a science. But to discover the laws of operative power in material productions, whether formed by man, or brought into being by nature herself, is the work of a science, and is indeed what we more especially term science, and thus, in the case with which we have to do, we have, instead of the criticism which naturally comes after the general circulation of poetry, the science which naturally comes after a great exhibition of art: two cases of succession connected by a very close and profound analogy. That this view of the natural and general succession of science to art, as of criticism to poetry, is not merely fanciful and analogical, we may easily convince ourselves by looking for an instant at the progress of art and of science in past times. For we see that, in general, art has preceded science. Men have executed great, and curious, and beautiful works before they had a scientific insight into the principles on which the success of their labors was founded. There were good artificers in brass and iron before the principles of the chemistry of metals were known; there was wine among men before there was a philosophy of vinous fermentation; there were mighty masses raised into the air, cyclopean walls and cromlechs, obelisks and pyramids—probably gigantic Doric pillars and entablatures,—before there was a theory of the mechanical powers. The earlier generations did; the later explained that it had been possible to do. Art was the mother of science: the vigorous and comely mother of a daughter of far loftier and serener beauty. And as it had been in the period of scientific activity in the ancient world, so was it again in the modern period in which science began her later growth. The middle ages produced or improved a vast body of arts. Parchment and paper, printing and engraving, glass and steel, compass and gunpowder, clocks and watches, microscopes and telescopes, not to speak of the marvels of architecture, sculpture, and painting, all had their origin and progress, while the sciences of recent times were in their cradle, or were unborn. The dawn of the sixteenth century presented, as it were, a Great Exhibition of the works which men had been producing from the time of the downfall of Roman civilization and skill. There too, might be seen, by him who travelled from land to land, beautiful textures, beautiful vessels of gold and bronze, of porcelain and glass, wonderful machines, mighty fabrics; and from that time, stimulated by the sight of such a mass of the works of human skill,—stimulated still more by the natural working of those powers of man from which such skill had arisen,—men were led to seek for science as well as art; for science as the natural complement of art, and fulfillment of the thoughts and hopes which art excites;—for science as the fully developed blossom, of which art is the wonderfully involved bud. Stimulated by such influences, the scientific tendencies of modern Europe took their starting impulse from the Great Exhibition of the productions of the middle ages which had accumulated in the sixteenth century; and have ever since been working onwards, with ever-increasing vigor, and in an ever-expanding sphere.

As the successful scientific speculations of the last three centuries have been the natural sequel to the art-energies of the preceding ages, so must the newest scientific speculations of our contemporaries and their successors, in order to be successful, be the result and consequence of the powers, as yet often appearing in the undeveloped form of art alone, which exist among us at the present day. And thus a great spectacle of the works of material art ought to carry with it its scientific moral. And the opportunities which we have lately had of surveying the whole of the world in which art reigns, and of appreciating the results of its sway, may well be deemed too valuable to be let slip for the purposes of that scientific speculation which is the proper sequence of such occasions. So it has seemed to those who have from the beginning taken a lofty, and comprehensive, and hopeful view of the great undertaking of which the first act is now completed; and especially to that mind which has always taken *the most* lofty, and comprehensive, and hopeful view.

And in order to carry into effect this suggestion, it has been determined that persons well qualified to draw from the spectacle the series of scientific morals which it offers, should present them to you here;—that critics should analyze for you some of the fine compositions with which you have become acquainted;—that men of science should explain to you what you ought to learn from such an exhibition of art. And it has been thought that it might not be useless that you should be reminded, in the first place, how great and unique the occasion is, and how peculiar are some of the lessons which even the most general spectator, unfit to enter into the details of any of the special arts, may draw from it.

For indeed it is obvious, at a glance, how great and unexampled is the opportunity thus given to us, of taking a survey of the existing state of art in every part of the world. I have said, that if, in the sixteenth century, an intelligent spectator could have travelled from land to land, he might, in that way, have seen a wonderful collection of the works of man in many different countries; and combining all these in his thoughts, he would have had in his mind a representation of the whole progress of human art and industry, up to the last moment, and a picture of the place which each nation at that moment occupied in the line of that progress. But what time, what labor, what perseverance, what hardships, what access to great and powerful men in every land, what happiness of opportunity, would be now implied in the completion of such a survey! A life would scarcely suffice for it; a man could scarcely be found who would achieve it, with all the appliances and means which wealth and power could give. He must, like the philosophers of ancient days, spend all his years of vigor in travelling; must roam in the varied regions of India; watch the artisan in the streets of the towns of China; dive into the mines of Norway and of Mexico; live a life in the workshops of England, France, and Germany; and trace the western tide of industry and art as it spreads over the valley of the Mississippi. And when he had done all this, and however carefully he had done it, yet how defective must it be at least in one point! How far must it be from a *simultaneous* view of the condition of the whole globle as to material arts. During the time that he has been moving from place to place, the face of the world has been rapidly changing. When he saw Tunis it was a barbarous state; now that he has to make up his account, it is the first which asks for a leading place among the civilized communities of the industrial world. When he visited the plains of Iowa and Wisconsin, they were wild prairie; they are now the fields from which the cereal harvest is swept by the latest improved reaping machine. When he was at the antipodes, the naked savage offered the only specimen of art in his rude club and frail canoe; now there is there a port whose lofty ships carry regularly to European markets multiplied forms of native produce and manufactures. Even if his picture be complete as to surface, what anachronisms must there be in it! How much that expresses not the general view of the earth, but the accidental peculiarities of the traveller's personal narrative! And then, how dim must be the images of the thing seen many years ago compared with that which is present to the eye! How impossible to compare the one with the other—the object now seen in age with a similar object remembered in youth! And after all, when we have assumed such a traveller—such a one as never has been—the Ulysses of modern times—seeing the cities of many men, and knowing their minds—seeing the workshops of all nations, and knowing their arts—we have but one such. His knowledge is only his. He cannot, in any clear or effective manner, communicate any large portion of it to others. It exists only for him—it perishes with him. And now let us, in the license of epical imagination, suppose such an Ulysses—much-seeing, much-wandering, much-enduring—to come to some island of Calypso, some well-inhabited city, under the rule of powerful and benignant, but plainly, he must believe, superhuman influences, and there to find that image of the world and its arts, which he had vainly tried to build up in his mind, exhibited before his bodily eye in a vast crystal frame;—true in every minutest thread and hue, from the sparkle of the diamond to the mighty bulk of the collossus; true to that which belongs to every part of the earth; and this, with the effects which the arts produce, not at the intervals of the traveller's weary journey, but everywhere at the present hour. And, further, let him see the whole population of the land—thousands upon thousands, millions upon millions, streaming to this sight, gazing their fill, day after day, at this wonderful vision, inviting the men of neighboring and of distant lands to gaze with them; looking at the objects, not like a fairy picture in the distant clouds, but close at hand; comparing, judging, scrutinizing the treasures produced by the all-bounteous earth, and the indomitable efforts of man, from pole to pole, and from east to west; or, as he would learn more truly to measure, from east to east again. When we have supposed such a vision, do we not seem to have gone beyond

> "Quicquid Grecia mendax
> Audit in historiâ;"

all the wonders of that wondrous ancient Odyssean tale? And yet, in making such a supposition, have we not been exactly describing that which we have seen within these few months? Have not we ourselves made part of the population of such a charmed isle,—of the crowds which have gazed on such a magic spectacle?

But now that we have had the spectacle before us, let us consider for a moment what the vision was, and what were the reflections which it excited. We had, offered to our review, the choicest productions of human art in all nations; or, at least, collections which might be considered as representing all nations. Now in nations compared with nations there is a difference; in a nation compared with itself at an earlier time, there is a progress. There may not always be a progress in good government; there may not necessarily be, though we would gladly hope that there is, a progress in virtue, in morality, in happiness. But there always is, except when very adverse influences roll back the common course of things, a progress in art, and generally in science. In the useful and ornamental arts nations are always going forwards, from stage to stage. Different nations have reached different stages of this progress, and all their different stages are seen at once, in the aspect which they have at this moment in the magical glass, which the enchanters of our time have made to rise out of the ground like an exhalation. The infancy of nations, their youth, their middle age, and their maturity, all appear in their simultaneous aspect, like the most distant objects revealed at the same moment by a flash of lightning in a dusky night:—or we may compare the result to that which would be produced, if we could suppose some one of the skillful photographers whose subtle apparatus we have had exhibited there, could bring within his field of view the surface of the globe, with all its workshops and markets, and produce instantaneously a permanent picture, in which the whole were seen side by side. But it is not a mere picture of things which are found standing together that we have had presented to us; the great achievement was the bringing them together. You have most of you probably heard of the careful and economical critic, who proposed to reduce the extravagance of the wish of the impatient separated lovers, that the gods would annihilate space *and* time; and who remarked that it would answer the end desired if one of the two were annihilated. By annihilating the space which separates different nations, we produce a spectacle in which is also annihilated the time which separates one stage of a nation's progress from another.

An ingenious speculator of our own day, clothing these metaphysical abstractions in the form which modern science assigns to them, has shown how we might, theoretically speaking, be, in a few instants, actual spectators, bodily and contemporaneous eye-witnesses, of all the events which have passed since man has existed upon earth. For, if we only imagine that, as the visual impressions on the vehicle of light, by which alone vision can take place, travel away from the scenes by the occurrence of which their configuration was given to them, we also travel after this moving vision, and go but a very little faster than light itself, we shall overtake successively the visual images of all successive events, and see them as truly as a distant spectator (and what spectator is not more or less distant?) sees what passes before his eyes. We might thus see now what is passing around us, and the next minute, by rushing to the borders of the solar system, where the images are still travelling outwards, see the first inhabitant of this island placing his foot upon its coast; and in the intermediate distances we should successively overtake and see, with our bodily eyes, in inverted order, the events of the English, Norman, Saxon, Roman, and British times; and we might mark, at each period, the food, the clothing, the arms, the tools, the houses, the machines, and the ornaments of the various eras.

Now that which this scientific dream thus presents to us in imagination, the Exhibition of the Industry and Arts of all Nations has presented as a visible reality; for we have had there collected examples of the food and clothing and other works of art of nations in every stage of the progress of art. From Otaheite, so long in the eyes of Englishmen the type of gentle but uncultured life, Queen Pomare sends mats and cloth, head-dresses and female gear, which the native art of her women fabricates from their indigenous plants. From Labuan, the last specimen of savage life with which this country has become connected, we have also clothes and armor, weapons and musical instruments. From all the wide domains which lie within or around our Indian empire we have rich and various contributions; from Singapore and Ceylon, Celebes and Java, Mengatal and Palembang. The ruder and more primitive of these regions send us their native food and clothing, their fishing nets and baskets; but art soon goes beyond these first essays. From Sumatra we have the loom and the plough. lacquered work and silken wares; and as we proceed from these outside regions to that central and ancient India, so long the field of a peculiar form of civilization, we have endless and innumerable treasures of skill and ingenuity, of magnificence and beauty. And yet we perceive that, in advancing from these to the productions of our own form of civilization, which has, even in that country, shown its greater power, we advance also to a more skillful, powerful, comprehensive, and progressive form of art. And looking at the whole of this spectacle of the arts of life in all their successive stages, there is one train of reflection which cannot fail I think to strike us; namely, this:—In the first place, that man is, by nature and universally, an artificer, an artisan, an artist. We call the nations, from which such specimens came as those which I first mentioned, rude and savage, and yet how much is there of ingenuity, of invention, of practical knowledge of the properties of branch and leaf, of vegetable texture and fibre, in the works of the rudest tribes! How much, again, of manual dexterity, acquired by long and persevering practice, and even so, not easy! And then, again, not only how well adapted are these works of art to the mere needs of life, but how much of neatness, of prettiness, and of beauty too, do they often possess, even when the work of savage hands! So that man is naturally, as I have said, not only an artificer, but an artist. Even we, while we look down from our lofty summit of civilized and mechanically-aided skill upon the infancy of art, may often learn from them lessons of taste. So wonderfully and effectually has Providence planted in man the impulse which urges him on to his destination,—his destination, which is, to mould the bounty of nature into such forms as utility demands, and to show at every step that with mere utility he cannot be content. And when we come to the higher stages of cultured art—to the works of nations long civilized, though inferior to ourselves, it may be, in progressive civilization and mechanical power, how much do we find in their works which we must admire, which we might envy, which, indeed, might drive us to despair! Even still, the tissues and ornamental works of Persia and of India have beauties which we, with all our appliances and means, cannot surpass. The gorgeous East showers its barbaric pearl and gold into its magnificent textures. But is there really anything *barbaric* in the skill and taste which they display? Does the oriental prince or monarch, even if he confine his magnificence to native manufactures, present himself to the eyes of his slaves in a less splendid or less elegant attire than the nobles and the sovereigns of this our western world, more highly civilized as we nevertheless deem it? Few persons I think would answer in the affirmative. The silks and shawls, the embroidery and jewellery, the moulding and carving, which those countries can produce, and which decorate their palaces and their dwellers in palaces, are even now such as we cannot excel. *Oriental* magnificence is still a proverbial mode of describing a degree of splendor and artistical richness which is not found among ourselves.

What, then, shall we say of ourselves? Wherein is our superiority? In what do we see the effect, the realization, of that more advanced stage of art which we conceive ourselves to have attained? What advantage do we derive from the immense accumulated resources of skill and capital—of mechanical ingenuity and mechanical power—which we possess? Surely our imagined superiority is not all imaginary; surely we really are more advanced than they, and this term "advanced" has a meaning; surely that mighty thought of a PROGRESS in the life of nations is not an empty dream; and surely our progress has carried us beyond them. Where, then, is the import of the idea in this case? What is the leading and characteristic difference between them and us, as to this matter? What is the broad and predominant distinction between the arts of nations rich, but in a condition of nearly stationary civilization, like oriental nations, and nations which have felt the full influence of progress like ourselves?

If I am not mistaken, the difference may be briefly expressed thus:—That in those countries the arts are mainly exercised to gratify the tastes of the few; with us, to supply the wants of the many. There, the wealth of a province is absorbed in the dress of a mighty warrior; here, the gigantic weapons of the peaceful potentate are used to provide clothing for the world. For that which makes it suitable that machinery, constructed on a vast scale, and embodying enormous capital, should be used in manufacture, is that the wares produced should be very great in quantity, so that the smallest advantage in the power of working, being multiplied a million fold, shall turn the scale of profit. And thus such machinery is applied when wares are manufactured for a vast population;—when millions upon millions have to be clothed, or fed, or ornamented, or pleased, with the things so produced. I have heard one say, who had extensively and carefully studied the manufacturing establishments of this country, that when he began his survey he expected to find the most subtle and refined machinery applied to the most delicate and beautiful kind of work—to gold and silver, jewels and embroidery; but that when he came to examine, he found that these works were mainly executed by hand, and that the most exquisite and the most expensive machinery was brought into play where operations on the most common materials were to be performed, because these were to be executed on the widest scale. And this is when coarse and ordinary wares are manufactured for the many. This, therefore, is the meaning of the vast and astonishing prevalence of machine-work in this country:—that the machine with its million fingers works for millions of purchasers, while in remote countries, where magnificence and savagery stand side by side, tens of thousands work for one. There Art labors for the rich alone; here she works for the poor no less. There the multitude produce only to give splendor and grace to the despot or the warrior whose slaves they are, and whom they enrich; here the man who is powerful in the weapons of peace, capital and machinery, uses them to give comfort and enjoyment to the public, whose servant he is, and thus becomes rich while he enriches others with his goods. If this be truly the relation between the condition of the arts of life in this country and in those of others, may we not with reason and with gratitude say, that we have indeed reached a point beyond theirs in the social progress of nations?

I have, perhaps, detained you too long with these general reflections, suggested by the mere general aspect of that great display of the works of nations in every stage of progress, which we have had lately before our eyes. But I hope you will recollect, that I began by claiming the privilege of speaking as a mere spectator, who had not had occasion to study the objects there assembled in a special and official manner. There is, however, one view of the subject, perhaps, a little less obvious, which I should wish to endeavor to bring before you: I mean, the view suggested by the *classification* of which such a collection has been found to be capable. Perhaps, at the first thought it might be supposed that to divide any collection of things, however numerous and various, into classes, is a work of no great difficulty, though when the collection is great, it may require much time. For it might be said, You have only to determine according to what resemblances and what differences you will make your classes, and then to go through the work, sticking to these. But any one who has attended a little more to the science of classification, or even who has made the attempt on any considerable scale, knows that this is not so; and that, unless the scheme of classes be very skillfully and very happily devised, it lands us in intolerable incongruities, and even in impossibilities. Indeed, without seeking any exemplification of this remark in the classificatory sciences, which can throw on this subject only a distant and doubtful light, we have experimental evidence of the difficulty of classifying a great collection of the products of art and industry, in the attempts which were made to perform that task on the occasions of the French *Expositions* in 1806, in 1819, in 1827, in 1834, and in 1844. On the first occasion, the distribution adopted was entirely geographical; on the second, it was what was called an entirely material or natural system, dividing the arts into thirty-nine heads, the consequence of which is said to have been great confusion. In 1827, a purely scientific arrangement was attempted, into five great divisions, namely, *chemical*, *mechanical*, *physical*, *economical*, and *miscellaneous arts*. But this was deemed too artificial and abstract, and in 1834 M. Dupin made the division depend on the relation of the arts to man, as being *alimentary*, *sanitary*, *vestiary*, *domiciliary*, *locomotive*, *sensitive*, *intellectual*, *preparative*, *social*. This analysis was also adhered to in 1839. In 1844, an attempt was made to unite some features of the previous systems, and the objects were classified as *woven*, *mineral*, *mechanical*, *mathematical*, *chemical*, *fine arts*, *ceramic*, and *miscellaneous;* which was still complained of as confused, but which was, on the whole, retained in 1849.

I do not think there is any presumption in claiming for the classification which has been adopted in the Great Exhibition of 1851 a more satisfactory character than we can allow to any of those just mentioned, if we ground our opinion either upon the way in which this last classification was constructed, or upon the manner in which it has been found to work. And there is one leading feature in it which, simple as it may seem, at once gives it a new recommendation. In the systems already mentioned there were no *gradations* of classification. There were a certain number, thirty-nine or five, nine or eight, of co-ordinate classes, and that was all. In the arrangement of the Great Exhibition of 1851, by a just and happy thought, a division was adopted of the objects to be exhibited into four great *sections*, to which other *classes*, afterwards established, were to be subordinate; these sections being, *raw materials, machinery, manufactured goods, and the works of the fine arts.* The effect of this grand division was highly beneficial, for within each of these sections classes could be formed far more homogeneous than was possible while these sections were all thrown into one mass; when, for instance, the cotton-tree, the loom, and the muslin, stood side by side, as belonging to *vestiary* art; or when woven and dyed goods were far removed, as being examples, the former of *mechanical*, the latter of *chemical* processes. Suitable gradation is the *felicity* of the classifying art, and so it was found to be in this instance.

But within this limit how shall classes be formed? Here, also, it appears to me, simply as a reader of the history of the Exhibition, which any one else may read, that the procedure of those who framed the classification was marked with sound good sense and a wise rejection of mere technical rules. For by assuming fixed and uniform principles of classification we can never obtain any but an artificial system, which will be found, in practice, to separate things naturally related, and to bring together objects quite unconnected with each other. It was determined, that within each of the four sections the divisions which had been determined by commercial experience to be most convenient should be adopted. "Eminent men of science and of manufactures in all branches were invited to assist in drawing each one the boundaries of his own special class of productions."* And it was resolved, for the general purposes of the Exhibition, to adopt thirty broad divisions; of which classes, four were of raw materials; six of machinery; nineteen of manufactures; and one of the Fine Arts. And these thirty Classes may be considered as having been confirmed by their practical application to the collection, and to the work of the juries in dealing with it; except that, in some instances, it was found necessary to subdivide a Class into others. Thus Class X, which was originally described as philosophical instruments, was found to consist of materials so heterogeneous, that there were separated from it three Classes, of musical, of horological, and of surgical instruments. And to Class V, machines, was added an accessory Class, V *a*, carriages. And, on the other hand, Classes XII, and XV, woollen and worsted, it was found could be advantageously thrown into one.

Within these classes, again, were other subdivisions, which are marked in the Catalogue by letters of the alphabet. Thus, the third Class consists of *substances used for food;* and of these the vegetable division contains *sub-classes,* A, B, C, D, E, F, G: the *first* being *cereals,* and the like; the *second, fruits;* the *third, drinks,* and so on. And in like manner, the sixth class, *manufacturing machines and tools,* had sub-classes, A, B, C, D, E, F:

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* "Illustrated Catalogue," Introd., p. 22.

as A, all *spun and woven fabrics;* B, *manufactures of metals;* C, *manufactures of minerals and mining machinery*, and the like.

And, again, each of these sub-classes was separated into heads, by numbers. Thus, the sub-class *cereals* and the like, are 1, the *common cereals;* 2, the *less common;* 3, *millet;* 4, *pulse and cattle-food;* 5, *grasses and roots;* 6, *flours* (ground grain); 7, *oil seeds;* 8, *hops.* And the sub-class A, of *manufacturing machines and tools*, included the heads, 1, *machinery for spinning and weaving cotton, wool, flax, hemp, silk,—for working caoutchouc, gutta percha, hair;* 2, *paper-making;* 3, *printing.* And to shew how much practical experience governed these subdivisions, I may mention that great aid in this task was found in the Trades' Directories of Birmingham and Manchester, and other great manufacturing towns.

I have followed this classification into the ultimate ramification of the Catalogue, at the risk of being, I fear, tedious for a moment; partly because I wish to make a reflection upon it; and partly, also, that you may see what a vast work is performed if this classification be really coherent and sound. For, first, turn your attention to the one head which I have mentioned; this single head includes no less than this,—all machinery for the complete formation, from the raw material, of all fabrics of cotton, wool, flax, hemp, silk, caoutchouc, gutta percha, and hair. This is head 1 of sub-class A. Under this head, or under the first particular head, *cotton*, are very many *articles* in the great exhibition. Besides this particular head, and the other particular heads, *wool, flax, caoutchouc, &c.*, included in the general head 1, there are two other heads in this sub-class, each of like extent. Along with this sub-class A, are also sub-classes B, C, D, E, F, each of an extent not inferior to A; and thus, this Class VI, contains a great mass of heads, each including a vast number of articles. Yet in the Catalogue, this Class VI, is one of the smallest extent of all the thirty. And though this may arise in part from some of the others being followed out into greater comparative detail than this Class VI, yet still enough will remain in this mode of putting the matter to shew you how vast and varied is the mass of objects which has thus been classified, and how great the achievement is if this mass have really been reduced into permanent order; if this chaos, not of elements only, but of raw materials mixed with complicated machines, with manufactured machines, with manufactured goods and sculptured forms, have really been put in a shape in which it will permanently retain traces of the ordering hand.

What the value and advantage would be of a permanent and generally accepted classification of all the materials, instruments, and productions of human art and industry, you will none of you require that I should explain at length. One consequence would be that the manufacturer, the man of science, the artisan, the merchant, would have a settled common language, in which they could speak of the objects about which they are concerned. It is needless to point out how much this would facilitate and promote their working together; how fatal to coöperation is diversity and ambiguity in the language used. One of our old verse writers, expanding according to the suggestions of his fancy, the account of the failure of men in the case of the tower of Babel, has made this cause of failure very prominent. He supposes that, the language of the workmen being confounded, when one of them asked for a spade, his companion brought him a bucket; or when he called for mortar, handed him a plumb-line; and that, by the constant recurrence of these incongruous proceedings, the work necessarily came to a stand. Now the conditions necessary, in order that workmen may work together, really go much farther than the use of a common language, in the general sense of the phrase. It is not only necessary that they should call a brick a brick, and a wire a wire, and a nail a nail, and a tube a tube, and a wheel a wheel; but it is desirable, also, that wires, and nails, and tubes, and wheels, should each be classified and named, so that all bricks should be of one size, so that a wire number 3, or a tube section 1, or a six-inch wheel, should have a fixed and definite signification; and that wires, and tubes, and wheels, should be constructed so as to correspond to such significations; and even, except for special purposes, no others than such. It may easily be conceived, for instance, how immensely the construction, adjustment, and repair of wheelwork would be facilitated, if wheels of a certain kind were all made with teeth of the same kind, so that any one could work in any other. And something of this sort,—something which secures some of these and the like advantages, has been done with reference to cast-iron toothed wheels. And an eminent engineer, whose works stood in the sixth class of the collection to which I have just referred, has proposed a system by which a like uniformity should be secured in the dimensions and fitting of machinery; and especially with regard to screws; fixing thus their exact diameter and pitch, as it is called—a process which would have the like effect of making the construction, application, and repair of all work into which screws enter vastly more easy and expeditious than it now is. Now these are the great and beneficial effects which follow from a good and generally accepted sub-classification of one of the lowest members of that classification which the Catalogue exhibits to us. Mr. Whitworth would classify screws, and wheels, and axles, as the millwrights have classified toothed wheels. But screws, or wheels, or axles, are merely one kind of tool, one element of machinery; and tools and machinery are only one class out of thirty of the great collection of which we are speaking. If, then, so great benefits arise from a common understanding as to the species of one of the lowest members of our classification, may we not expect corresponding advantages from a fixation of the names and distinctions of the higher members?—of the names of tools and machines, for instance; and from a perception of their relations to each other, which a good classification brings into view; and then, again, from a clear perception of the relation of class to class and of their lines of demarkation? And may we not expect that on such grounds, the very language of art and industry, and the mode of regarding the relations of their products, shall bear for ever the impress of the Great Exhibition of 1851?

There is one other remark which I should wish to make, suggested by the classification of the objects of the Exhibition; or, rather, a remark which it is possible to express, only because we have such a classification before us. It is an important character of a right classification, that it makes general propositions possible; a maxim which we may safely regard as well grounded since it has been delivered independently by two persons, no less different from one another than Cuvier and Jeremy Bentham. Now, in accordance with this maxim, I would remark, that there are general reflections appropriate to several of the divisions into which the Exhibition is by its classification distributed. For example, let us compare the first class, *mining and mineral products*, with the second class, *chemical processes and products*. In looking at these two classes, we may see some remarkable contrasts between them. The first class of arts, those which are employed in obtaining and working the metals, are among the most ancient; the second, the arts of manufacturing chemical products on a large scale, are among the most modern which exist. In the former class, as I have said, art existed before science; men could shape, and melt, and purify, and combine the metals for their practical purposes, before they knew any thing of the chemistry of metals; before they knew that to purify them was to expel oxygen or sulphur; that combination may be definite or indefinite. Tubal-Cain, in the first ages of the world, was "the instructor of every artificer in brass and iron;" but it was very long before there came an instructor to teach what was the philosophical import of the artificer's practice. In this case, as I have already said, art preceded science; if even now science has overtaken art; if even now science can tell us why the Swedish steel is still unmatched, or to what peculiar composition the Toledo blade owes its fine temper, which allows it to coil itself up in its sheath when its rigid thrust is not needed. Here art has preceded science, and science has barely overtaken art. But in the second class, science has not only overtaken art, but is the whole foundation, the entire creator of the art. Here art is the daughter of science. The great chemical manufactories which have sprung up at Liverpool, at Newcastle, at Glasgow, owe their existence entirely to a profound and scientific knowledge of chemistry. These arts never could have existed if there had not been a science of chemistry; and that, an exact and philosophical science. These manufactories now are on a scale at least equal to the largest establishments which exist among the successors of Tubal-Cain. They occupy spaces not smaller than that great building in which the productions of all the arts of all the world were gathered, and where we so often wandered till our feet were weary. They employ, some of them, five or six large steam-engines; they shoot up the obelisks which convey away their smoke and fumes to the height of the highest steeples in the world; they occupy a population equal to that of a town, whose streets gather round the walls of the mighty workshop.* Yet these processes are all derived from the chemical theories of the last and the present century; from the investigations carried on in the laboratories of Scheele and Kirwan, Berthollet and Lavoisier. So rapidly in this case has the tree of art blossomed from the root of science; upon so gigantic a scale have the truths of science been embodied in the domain of art.

Again, there is another remark which we make in comparing the first class, *minerals*, with the third class, or rather with the fourth, *vegetable and animal substances used in manufactures, or as implements or ornaments.* And I wish to speak especially of *vegetable* substances. In the class of *minerals*, all the great members of the class are still what they were in ancient times. No doubt a number of new metals and mineral substances have been discovered; and these have their use; and of these the Exhibition presents fine examples. But still, their use is upon a small scale. Gold and iron, at the present day, as in ancient times, are the rulers of the world; and the great events in the world of mineral art are not the discovery of new substances, but of new and rich localities of old ones,—the opening of the treasures of the earth in Mexico and Peru in the sixteenth century, in California and Australia in our own day. But in the vegetable world the case is different; there, we have not only a constant accumulation and reproduction, but also a constantly growing variety of objects, fitted to the needs and uses of man. Tea, coffee, tobacco, sugar, cotton, have made man's life, and the arts which sustain it, very different from what they were in ancient times. And no one, I think, can have looked at the vegetable treasures of the Crystal Palace without seeing that the various wealth of the vegetable world is yet far from exhausted. The

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* "Illustrated Catalogue," p. 184.

Liverpool Local Committee have enabled us to take a starting-point for such a survey, by sending to the Exhibition a noble collection of specimens of every kind of import of that great emporium; among which, as might be expected, the varieties of vegetable produce are the most numerous. But that objects should be reckoned among *imports*, implies that already they are extensively used. If we look at the multiplied collections of objects of the same kind, some from various countries, not as wares to a known market, but as specimens and suggestions of unexplored wealth, we can have no doubt that the list of imports will hereafter, with great advantage be enlarged. Who knows what beautiful materials for the makers of furniture are to be found in the collections of woods from the various forests of the Indian Archipelago, or of Australia, or of Tasmania, or of New Zealand? Who knows what we may hereafter discover to have been collected of fruits and oils, and medicines and dyes; of threads and cordage, as we *had* here from New Zealand and from China examples of such novelties; of gums and vegetable substances, which may, in some unforeseen manner, promote and facilitate the processes of art? How recent is the application of caoutchouc to general purposes! Yet we know now—and on this occasion America would have taught us if we had not known—that there is scarcely any use to which it may not be applied with advantage. If a teacher in our time were to construct maxims like those of the son of Sirach in the ancient Jewish times—like him who says (Ecclus. xxxix. 26) "The principal things for the whole use of man's life are water, fire, iron and salt, flour of wheat, honey, milk, and the blood of the grape, oil, and clothing"—he could hardly fail to make additions to the list, and these would be from the vegetable world. Again, how recent is the discovery of the uses of gutta percha! In the great collection were some of the original specimens sent by Dr. Montgomery to the India House, whence specimens were distributed to various experimentalists.* Yet how various and peculiar are now its uses, such as no other substance could replace! And is it not to be expected that our contemporaries, joining the insight of science to the instinct of art, shall discover, among the various sources of vegetable wealth which the Great Exhibition has disclosed to them, substances as peculiar and precious, in the manner of their utility, as those aids thus recently obtained for the uses of life?

And before we quit this subject, let us reflect, as it is impossible, I think, not to reflect, when viewing thus the constantly enlarging sphere of the utility which man draws from the vegetable world, what a view this also gives us of the bounty of

* "Illustrated Catalogue," p. 876.

Providence to man, thus bringing out of the earth, in every varying clime, endless forms of vegetable life, of which so many, and so many more than we yet can tell, are adapted to sustain, to cheer, to benefit, to delight man, in ways ever kind, ever large, ever new, and of which the novelty itself is a new source of delighted contemplation.

I might go on to make other reflections upon the peculiar characters of the various classes of the Great Exhibition, but the time does not allow me, nor is it needful, since all that I aspired to do was to offer to you specimens of such reflections. Several of the classes will, no doubt, suggest appropriate reflections to those who have to deliver lectures to you on special subjects. In the meantime, though I must now hasten to a conclusion, I cannot but perceive how imperfectly I have discharged even the limited task which I ventured to undertake. For I have as yet said nothing of the effect which must be produced upon art and science by this gathering of so many of the artists and *scientists* (if I may use the word) of the world together; by their joint study of the productions of art from every land, by their endeavors to appreciate and estimate the merits of productions, and instruments of production; of works of thought, skill, and beauty.

In speculating concerning universities, we are accustomed to think that, without underrating the effect of lectures and tasks, of professors and teachers, still that among the most precious results of such institutions is the effect produced upon those who resort thither by their intercourse with, and influence upon, each other. We know that by such intercourse there is generated a community of view, a mutual respect, and a general sympathy, with regard to the elements of a liberal education, and the business of national, social, and individual life, which clings to men ever after, and tends to raise all to the level of the best. And some such effect as this would, we may suppose, be produced upon the students of the useful and the beautiful arts by their resort to any university in common. To *any* university, I have said; but to what a university have they been resorting during the past term? To a university of which the colleges are all the great workshops and workyards, the schools and societies of arts, manufactures, and commerce, of mining and building, of inventing and executing in every land—colleges in which great chemists, great machines, great naturalists, great inventors, are already working, in a professional manner, to aid and develop all that capital, skill, and enterprise can do. Coming from such colleges to the central university, may we not well look upon it as a great epoch in the life of the material arts, that they have thus begun their university career—that they have had the advantage of such academical arrangements as there have been found, and still more, as I have said, that they have had the greater advantage of intercourse with each other? May we not expect that from this time the eminent producers and manufacturers, artisans and artists, in every department of art, and in every land, will entertain for each other an increased share of regard and good-will, of sympathy in the great objects which man's office as producer and manufacturer, artisan and artist, places before him—of respect for each other's character, and for the common opinion of their body, all increased by their being able to say, "We were students together at the Great University in 1851."

ART. XXXIII.—*On Octahedral Oligist Iron;* by T. S. HUNT, of the Geological Commission of Canada.

[Read before the American Association for the Advancement of Science, at Albany, September, 1851.]

THE notion of polymerism derived from the investigations in organic chemistry is already being extended to mineral chemistry, and has aided in simplifying and elucidating many difficult questions. Such a question is presented in the difference between the persalts and protosalts of iron, which are as widely dissimilar in their chemical characters and their equivalents as the salts of two distinct metals; their composition may be represented by saying that in the persalts the ferruginous element combines in a proportion which is two-thirds of that in the protosalts. Designating the one as *ferrosum*, with an equivalent of 28· ($H=1$), the other will be *ferricum* with the equivalent 18·66; these being to each other as 3 : 2, we may readily imagine a polymerism as in the different metaphosphoric acids of Fleitmann, or the many instances met with in organic compounds, and suppose that in one case three atoms of *ferrum*, and in another two, are condensed into one equivalent. The same view is of course extended to the sesquioxyds of aluminium, manganese and chromium.* MM. Gerhardt and Laurent have shown that these sesquioxyds may indefinitely replace protoxyds in crystalline minerals without affecting the form of the crystals, that in other words, the sesquioxyds represented as protoxyds of ferricum, aluminicum, etc., and

* These views were, I believe, first suggested by myself in this Journal, for September, 1848, p. 170, and subsequently in a thesis on chemical classification presented to the American Association for the Advancement of Science, at Philadelphia, September, 1848, and published in this Journal, July, 1849. See vol. viii, p. 93, and a note, p. 94. M. Laurent, in a memoir upon the silicates in the Comptes Rendus des Travaux de Chemie, for August, 1849, p. 259, has reproduced the views which I had there advanced. The germ of the idea is found in the molecular theory of Ampère, and I have since found that my suggestion with regard to sulphur had been anticipated by M. Gerhardt in a note at p. 90 of his Comptes Rendus for 1847.

written $Fe\beta_2O$, $Al\beta_2O$, are isomorphous with Fe_2O, Mg_2O and Zn_2O. The analyses of many species of silicious minerals prove that while the proportion between the oxygen of the silica and that of the bases is a constant ratio in a given species; that between the oxygen of the protoxyds and sesquioxyds is exceedingly variable. Thus in the epidotes while the first ratio is one of equality, the second ranges from 2:1 to 1:1, and yet these varieties have all the same crystalline form, and specific characters.*

M. Kopp, it is well known, has shown that the expression obtained by dividing the atomic weight of different substances by

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* The analyses of many species besides epidote confirm this principle; the garnets, idocrase, many feldspars, prehnites, and the zeolites, furnish ample proofs of the isomorphism of $Al\frac{2}{3}$ O, and $Fe\frac{2}{3}$ O, with the protoxyds. But in the hornblendes and pyroxenes and in the varieties of kyanite this law no longer holds good. Neither is it possible in adopting the ordinary notation to reduce the aluminous pyroxenes and hornblendes to a common formula with those containing protoxyds only, with which however they correspond in physical characters, and as Dana has shown, in atomic volume. The analyses of fibrolite, bucholzite, sillimanite and kyanite, all of which are included by Mr. Dana under the latter species, show between the oxygen of the silica and alumina, the ratios of 6:6, 6:5 and 6:4, yet he has shown that for all these the atomic volume remains the same, while for andalusite, which has a different crystalline form and the relation of 6:9, the volume of the atom scarcely varies from that of kyanite. We are led to adopt the view proposed by Rammelsberg, that in the pyroxenes and hornblendes, alumina replaces in part the silica, and to extend this view to the kyanites and probably to some other species. On an examination of the analyses of the aluminous pyroxenes and hornblendes, it will be found that on adding the oxygen of the alumina to that of the silica, the sum bears to that of the oxygen of the protoxyd bases, the same relation as exists in those varieties which contain no alumina. Silica represented as $Si\,O_3$ then becomes chemically equivalent to $Al_2\,O_3$ (or $Al_4\,O_3$ in the notation here adopted); but this is equal to $al_6\,O_3$ or $3(al_2\,O)$, and six atoms of *aluminicum* are then equivalent to one of silicon in $Si\,O_3$, or al_2 to Si if we write silica $Si_3\,O_3$. This peculiar function of alumina is then connected with a change of equivalent, and is a case in point to illustrate our idea of polymerism connected with a change of chemical relations. The relation which aluminium in this combination sustains to the basic aluminicum, is analogous to that which Mn_2 and Cr_2 sustain to Mn_2 mn_2 and cr_2 in their saline combinations, when losing their basic characters they become equivalent to S, in the manganates and chromates, the homologous isomorphs of the sulphates. $Cr_2\,H_2\,O_4$ corresponds to $SH_2\,O_4$; but $Cr_2 = cr_3$ is the equivalent of S precisely as al_6 becomes the equivalent of Si.

The silica in these aluminous minerals may then be replaced to a varying extent by alumina, and if from a comparison of the chemical analyses of epidotes, zeolites, etc., with their crystalline forms and densities, it is shown that alumina may replace the protoxyd bases, it is equally established upon the same grounds, that in some other minerals, alumina takes the place of silica. In the one case al_2 O, assumes the form and atomic volume of Mg_2 O, and in the other, $3al_2$ O sustains the same relations to $Si\,O_3$.

If we compare alumina and silica in their uncombined states, we find that sapphire has an atomic volume of 12·9, that of quartz being 17·; as great differences as this exist between members of an acknowledged isomorphous series as between calcite and calamine, which also differ in their angles by 2°·30′. The difference between the angle R : R in quartz which is 94°·15 and sapphire which gives 86°·6′, is perhaps too great to permit these two species to be considered as isomorphous; the limit of variation however in form and volume for bodies thus related does not seem to be fixed. Rose establishes a relation of this kind between bournonite and nitre which differ nearly 4° in their angles. See this Journal, [2], vol. ix, p. 220. We propose to return to this subject at an early occasion.

their specific weights, representing the comparative volume of their atoms, is nearly the same for isomorphous bodies, and this subject has been greatly extended by Mr. Dana in a late paper in this Journal. M. Gerhardt then having pointed out the isomorphism of the protoxyds and sesquioxyds, endeavored to show that they have the same atomic volume, that in other words 18·6 parts of iron in the form of peroxyd occupy the same volume as 28 parts in the state of peroxyd. The results of his inquiry will be found in this Journal, vol. iv, p. 405; he has there shown that franklinite, the various spinels and chromic irons when reduced to the formula of magnetic iron, have all the same atomic volume, and that periclase a pure protoxyd, crystallizing in the regular system enters into the same series. We have since been enabled to add to the list the artificially formed crystals of protoxyd of nickel described by Genth, having a specific gravity of 6·605 which gives an atomic volume of 11·4, that of magnetite being 11·2 and that of periclase 10·9. Although the correspondence between these protoxyds and the compounds of the two classes of oxyds might be regarded as establishing the point, it was desirable to add to the series a pure peroxyd.

Such is the *martite* of Breithaupt which he has described as a peroxyd of iron, crystallizing in forms of the regular system, and having a specific gravity of 4·65—4·82, which gives an atomic volume of 11. These crystals have however been looked upon as pseudomorphs after magnetite, and Dana in the last edition of his Mineralogy regards their nature as doubtful. The question involved in establishing the martite of Breithaupt was then not merely that of fixing a single species in the science, but of confirming also the isomorphism and identity of atomic volume of *ferricum* and *ferrosum*. It is for this reason that we have thought it proper to prefix these remarks to a description of a new locality of martite, occurring under circumstances which seem to preclude the idea that the mineral is the result of metamorphism.

In examining the collection of Dr. Holmes of this city I found a specimen which he had received through the late Dr. Horton, from Munroe, New York, as crystallized ilmenite. Its monometric form led me to suppose it to be the octahedral titaniferous iron to which the name of *iserine* has been given,* but on ex-

* The titaniferous irons have been described as crystallizing occasionally in forms of the regular system with the same specific gravity as the rhombohedral variety. M. Gerhardt in the article already referred to has shown that the mean atomic volume of these compounds is 10·9. They are generally represented as consisting of titanate of protoxyd of iron crystallizing with variable portions of the sesquioxyd. The different formulas cited by Gerhardt give one, three, six and eight equivalents of titanate (FeO, TiO_2) to one of sesquioxyd, and 2 : 5 in another case. But Rose has shown that the ferrous oxyd and titanic acid obtained in the analyses, result from the reaction in the process of solution between sesquioxyd of iron and sesquioxyd of titanium, $Fe_2O_3+Ti_2O_3=2(FeO, TiO_2)$.* If we write the for-

* See this Journal, [2], vol. ii, p. 33.

amination it was found to contain only oxyd of iron. It occurs in an aggregate of white translucent quartz, flesh-colored feldspar and dark green hornblende, the latter sometimes in crystals. The oxyd of iron is found alike imbedded in all these species, in crystals which are seldom more than one-tenth of an inch in diameter. Their form is that of a regular octahedron, generally with the edges replaced, and often exhibiting the faces of the cube also in rounded grains. The crystals are frequently flattened and the extended faces are marked by delicate *striæ* in three directions parallel to the edges. Color iron-black, often with a bronzed tarnish; streak, purple-brown; lustre, sub-metallic; fracture, conchoidal, cleavage very indistinct; not magnetic even in powder. Hardness 6; gravity of crystals with some of the gangue still adherent, 5·165; reduced to powder and washed to remove the accompanying silicious minerals, 5·33. The crystals completely imbedded in the hornblende, were like the others octahedral and non-magnetic.

The pulverized mineral was readily soluble in heated hydrochloric acid, and the solution on dilution and boiling, deposited no titanic acid. The recent solution, air having been excluded, gave the reactions of a persalt without any traces of protosalt of iron, and the addition of ammonia precipitated peroxyd of iron from a colorless filtrate which was not disturbed by sulphuret of ammonium or phosphate of soda. It was hence inferred that the mineral is pure peroxyd of iron.

The existence of these crystals imbedded in unaltered dark green hornblende, a mineral which contains a large amount of protoxyd of iron, and is so readily decomposed by the oxydating action of atmospheric influences, forbids the idea that they are pseudomorphs formed by the oxydation of magnetite. They present an example of a sesquioxyd crystallizing in the regular system, and give for the oxyd of ferricum fe_2O (feO in the ordinary notation,) a volume which corresponds to that of the other monometric oxyds above mentioned. If we take the mean of the two determinations given, we have 5·25 for the specific gravity which gives an atomic volume of 10·15. The octahedral oligist iron is then clearly a distinct species and should be designated by the name of *martite*, already proposed by Breithaupt.

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mula of anhydrous titanic acid, TiO_2, the equivalent of titanium will be 24, (oxygen=8,) and *titanicum* corresponding to ferricum will be 16. The formulas of the different ilmenites and iserines will then be $fe\,O + ti\,O$, or in our notation $(fe, ti)\,O$, the proportions of the two peroxyds being very variable, and thus according to the view of H. Rose, monometric titaniferous irons are really examples of peroxyds having the form and atomic volume of magnetite and periclase. It is worthy of remark that the volume of the monometric and rhombohedral oligists and ilmenites is the same. If instead of assimilating alumina in the form of sapphire to quartz, we give it the formula al_4O_2, by which it can be compared with specular iron, its atomic volume will be 8·6, which approximates to those of periclase and martite.

ART. XXXIV.—*Some Thoughts on Prof. Hosking's Remarks on Ventilation;** by SAMUEL WEBBER.

ALTHOUGH in these modern days of discovery and invention we do not admit the strict truth of Solomon's remark, that there is nothing new under the sun, yet we are often reminded of it by seeing something brought forward with claims to novelty, that can be supported only by a forgetting of what has been done in by-gone times. Of this class seems to be Professor Hosking's plan for ventilation by means of a parlor fire, brought forward as a thing of comparatively recent invention. At least all of it but the ventilating opening into the flue of the chimney near the ceiling was almost exactly used a great many years ago; and the ventilating opening itself has long been familiar to those who have paid any attention to the subject.

One of the earliest things that we recollect in our boyhood, was a coal-grate furnished with tubes for bringing into the room a current of heated air from behind the grate whither it was conveyed by another tube communicating with the external air, an air chamber having been formed behind the grate for the purpose of receiving and heating it. This was about 1803 or 1804.

Not far from the same time, Mr. Allan Pollock, of Boston, invented an iron stove, in which the same principle was introduced. The stove itself was a close stove for burning wood, and the external air was introduced by a tube communicating with an air passage in the interior of the stove, whence, when heated, it issued into the room through an iron pipe opening on the top of the stove.

In 1815 and 1816, the principle was extensively employed in Boston and its vicinity in conjunction with open parlor fire-places for burning wood. The hearth was hollow, the upper surface upon which the fire rested being made of a thick iron plate. The sides and back of the fire-place were also hollow, and the upper part of the back was much inclined forward so as to render the opening into the chimney flue, or the throat of the chimney, as it was called, very narrow, thus throwing as much as possible of the direct heat of the fire into the room. A tube from without conducting the external air under the iron hearth and thence into the hollows of the sides and back, whence it issued through two openings made in front of the jambs that could be wholly or partially closed at pleasure by a sliding valve. We have often seen a small windmill made of card or pasteboard adjusted to one of these openings, and indicating by a greater or less swiftness of its rotation, the rapidity of the current of heated air issuing into the room.

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* See page 249 of this volume.

Here seem to be all the contrivances that Professor Hosking has brought forward, save the ventilating aperture into the chimney above, and the moveable valve in the throat of the flue which alone can render that aperture necessary for ordinary purposes. Even this moveable valve in the smoke flue has been in use from time immemorial in Russian stoves and for a vast many years under the name of *a damper*, in the close stoves in our own country. It is an objectionable piece of apparatus without the accompaniment of a ventilator, since while preventing in any considerable degree the escape of the heat from a room or from the fire, it likewise prevents the escape of the carbonic acid gas generated by respiration and combustion. But even with a close stove, if this be not used, or used only in a slight degree, so as to permit a free draught of air through the stove, unless the room be over-crowded with persons, there will be sufficient ventilation for the ordinary purposes of health and comfort. The opening by which the air has access to the fire in the stove is a sufficient ventilator.

Mr. Hosking, however, thinks it important that the opening should be near the ceiling of the room. If it be so placed it will counteract, in some degree, what he is endeavoring to obtain by his contrivances below, that is, warmth and purity of air, by conveying away almost perhaps as fast as it enters, the warm fresh air brought in by his heated air pipes below, as the hotest air will most readily escape from an opening in the top of the room, and that just delivered from the heated supply pipes or openings, will probably be the hottest. But his reasonings and statements on the condition and action of the air are so loose and unscientific, that it may be well, in order to present the subject fully, to go into a little examination of them.

He says, "open a window in an otherwise close room and no air will enter; no air can enter indeed, unless force be applied as with a bellows, whereby as much may be driven out as is driven in, with the effect only of diluting not of purifying."

Now so far from this being generally true, it can be so only under particular and somewhat rare circumstances, namely, when the air in the close room shall be of precisely the same temperature, and the same specific gravity as the external air. If the air contained in the room be warmer than the external air, immediately upon opening the window a double current will be established through the opening, an inward current of cold air at the bottom of the opening, and an outward current of warm air at the top. This double current will continue to act with full force till the cold air has replaced the warmer air of the room up to the bottom of the open window. The force of action will then be diminished and the depth of each current gradually lessened till the cold air has risen to the top of the opening of the window, after which the outward current will gradually lose its original warmth and force and a slight or inward current of cold air continue, till the whole of the interior of the room is cooled down to the temperature of the external air. If the inside of the room is constructed of materials that are not homogeneous in their power of conducting or radiating heat, various local currents of ascent and descent will be established in the room in addition to the actions of the great inward and outward currents.

If the conditions be reversed, so will the performance of the changes; that is, if the close room be colder than the external air, the inward current will be at the upper part of the opening, and the outward current at the lower part, and the current of warm air will be the last to cease; and under the same circumstances of want of homogeneity in the structure of the walls of the room, local currents will occur as before, only inversely. Generally speaking, the change will be effected by the substitution of the air without for that within, but not wholly so, for some of the internal air will be warmed or cooled by induction, from coming in contact with the external air of a different temperature from its own.

The completeness and quickness of the change will depend partly upon the size of the aperture, and partly upon its situation. Of course, the larger the opening, the more quickly will the exchange be effected. But in cases where the dimensions of the aperture are the same, and the size of the apartment the same, position has much effect. Thus, in the first supposition that the air of the room is warmer than the external air, an opening near the top of the room will most readily permit the warm air to escape and the colder and denser external air to descend to take its place, and leave but little to be cooled by induction, while with an opening of the same size near the floor, the warm air would escape after a little while with much difficulty, and much more of it would remain in the room cooled down to the temperature of the external air. The results would be reversed on the second supposition, that the air of the close room was colder than the external air.

So far then as to simply warm air and cold air Mr. Hosking's doctrine seems to be correct, as to the effect of a ventilating opening near the ceiling of a room being more effectual in changing thoroughly the air of an apartment, but it does it also by at the same time carrying off the warmth which is not desirable; and while the result is correct as to the change of air in this way, it is in contradiction to his premises, which state that such a change cannot be effected by a single opening in the side of a close room.

These changes are effected by the difference in the density of warm air and cold air; air being considered as a homogeneous fluid, of the same specific gravity at the same temperature. When therefore the temperature of the closed room and of the external air have become the same, the currents through the opening will cease, and mechanical compulsion will be needed to force the external air into the room. But if the room had within itself a permanent source of caloric or a permanent absorbent of it, the currents would be equally permanent, varying in force according to the difference of temperature between the external and internal air. Now the presence in such a room of a heated close stove (that is, a perfectly air tight stove,) or of one or more living animal bodies, would be for this argument a permanent source of caloric, and a large mass of ice, while it remained unmelted would answer for a permanent absorbent of caloric, provided that in the former case the external air was of a lower temperature than the natural heat of the animal bodies, and in the latter, that it was above the melting point of ice.

The heat imparted to the air by the living animal bodies is mainly derived from their respiration; but this not only warms the air, but alters its composition, imparting to it a considerable additional quantity of carbonic acid gas, and depriving it of a quantity of its oxygen. Now carbonic acid gas is of a decidedly greater specific gravity than oxygen or than ordinary atmospheric air. This mixture then alters the specific gravity of the air under equal degrees of temperature, and we are thus led to a second examination of principles.

If we could suppose a close room filled with carbonic acid gas of the same temperature as the external air, and then a window in the side to be opened; in consequence of the superior specific gravity of the gas, currents inwards and outwards would be formed in the same way, as when the room was filled with air colder than the external air. If the carbonic acid were rarified by being combined with such a portion of caloric, as should render its specific gravity equal to that of the external air, no currents would at first ensue upon opening the window. But they would soon begin to take place by the existence of a new principle of action. Caloric has a tendency to diffuse itself equably through all bodies in contact with each other, so as to bring them all to the same sensible temperature as measured by the thermometer. In consequence of this, some of the caloric combined with the carbonic acid would leave it, to combine with the colder air, with which it was brought in contact by the opening of the window. The portions of carbonic acid, thus deprived of their excess of caloric, would sink downward, part probably to the floor of the room and part through the opening of the window to the ground. The place of whatever sank downward to the floor would be occupied immediately by fresh portions of warm gas rushing up and in to fill the vacancy, in their turn to lose their excess of caloric, and sink like their predecessors, while any portion that passed outwardly to the ground would be replaced by a portion of the cooler external air that would press in to supply the vacuum; and this, receiving heat from the warmer carbonic acid in the room, would become more rare than the warm carbonic acid itself, and still more so than that which it had deprived of a portion of its caloric, and would rise rapidly to the top displacing and forcing downwards and outwards an equivalent bulk of the carbonic. Thus currents inwards and outwards would soon be established, which would soon reduce the whole carbonic acid to the temperature of the external air, and the level of it, to the bottom of the window.

When this takes place the regular action of the currents is very greatly checked, the carbonic acid below that level is cooled down to the temperature of the external air, and from its greater specific gravity is disposed to rest like a fluid within its lateral confining walls, with a level and even surface. But as water when so confined, if the external air has access to it, will gradually disappear, and mingle with the atmosphere, by the process of evaporation, so will the carbonic acid by a similar process, but much more rapidly, rise into combination with the air immediately above it, and through the opening be gradually dispersed into and combined with the general atmosphere, probably in currents similar to those before acting, but far more gentle in their motion. The ultimate result will be, that after a longer or shorter time the whole of the carbonic acid will have disappeared from the room, which will contain only atmospheric air of the same purity as that of the atmosphere which surrounds it; and yet Professor Hosking says that atmospheric air will not pass into an otherwise close room through an open window except propelled by force, and that even then it will only *dilute* impure air, and not purify it. If instead of the room being filled with carbonic acid, it were filled with hydrogen gas which is much lighter than atmospheric, the actions would all be inverted, but the result would be the same—the complete disappearance of the hydrogen, and the substitution of pure atmospheric air in its place.

Suppose that into a close and cold room a permanent source of pure caloric be introduced; the air immediately around it becoming heated will rise rapidly to the ceiling, and there diffuse itself, becoming cooler as it spreads along the ceiling, by imparting part of its caloric to that. The air around that which became heated and rose, will rush in and up, to take its place, become heated in its turn and rise, be diffused along the ceiling pressing forward that which rose before it. This will go on till all the cold air in the room has in its turn been heated and risen up to the ceiling, been diffused along it and forced down by its onward pressure and the obstacle of the sides of the room. Then that portion which rose first will come round to the source of caloric, to receive a fresh portion and to rise again as before; and this process will be repeated, till the whole of the air, if the room be perfectly close and the materials of the walls and ceiling and floor non-conductors of heat, will arrive at the same temperature with the body from whence it receives the caloric, when the currents of air will cease. But in case the walls, &c. are not non-conductors, some portion of caloric will always be imparted to and transmitted through them, and the portions of air from which it is received will descend to be heated again, thus the whole of the air will never as a body be raised to the temperature of the calorific source, and a constant circulation of currents will be kept up, more or less active according to the greater or less conducting power of the walls.

But there will not in any case be any permanent fixture of hotter air in the upper part of the room. There will be a current of hotter air moving along the ceiling in every direction from the spot immediately over the source of caloric downward on the sides, losing heat as it goes, if the walls and ceiling be not perfect non-conductors; and there will be a current of comparatively cooler air moving along the floor from all sides towards the calorific body, and this cooler air will also be denser, and therefore of greater specific gravity than the hotter air moving outwards on the ceiling. Yet as a whole the air of the higher part of the room will be the warmest.

If the calorific body possess also the property of imparting carbon to the oxygen of the air, forming carbonic acid gas, while the general action of the currents remains the same, they will be somewhat modified by this change in the nature of the air. The carbonic acid being of greater specific gravity will fall more readily on cooling, and more completely, while the excess of nitrogen, left by the withdrawal of the oxygen, will fall more slowly and less completely. The consequence seems to be, that in the warmer and higher part of the room there will be a preponderance of nitrogen and in the lower and cooler part, of carbonic acid. So that if an aperture were made in the higher part by which the air could be drawn off, the warmer air and especially the nitrogen, as having the least specific gravity would be drawn out first, and the cooler air and the carbonic acid last. The order of the process would be reversed if the aperture for drawing off the air were made in the lower part of the room.

Professor Hosking speaks of the upper part of a room being occupied by warm and spent air. If the word spent be taken very literally, he may be considered as right, *spent air* so taken meaning air deprived of its power of sustaining life, which would be the case with nitrogen; but if, as the context would warrant, he meant only air unfit to be breathed in consequence of having passed through the lungs, then it would appear that the lower part of the room occupied by the oxygen united in the lungs with carbon might well be said to be occupied with *spent* air. Any nitrogen or carbonic acid in excess in the air may alike be looked upon as impurities. But even in impurity there may be a choice of kinds, and the question arises, is it so in this case? This is easily answered, nitrogen is only negatively suffocating,—carbonic acid is positively poisonous. It is therefore more important to withdraw from an inhabited room the carbonic acid, and of consequence more important to have the ventilating aperture, if there be but one, near the floor, than near the ceiling; and if the preservation of warmth in the room be an object, this is also best promoted by the same arrangements. Another opening near the ceiling will also be advantageous, but it must be arranged with a view to as little escape of warmth as may be consistent with reasonable preservation of the purity of the air, at least when the retention of warmth is desirable.

If a close room be inhabited, carbonic acid is not the only impurity communicated to the air; there are frequently thrown off from the human body small portions of sulphuretted hydrogen and ammoniacal vapor, &c., which are as unfit for breathing or nearly so as carbonic acid. The quantity of these is very small, but as they are lighter than atmospheric air, they will rise to the upper part of the room and add positive bad qualities to the negative ones of the nitrogen, affording an additional reason for a ventilating opening near the ceiling.

The practical deductions from the foregoing principles seem to be these.

In the season of the year in which windows can be freely opened, rooms containing but few persons in proportion to their size, will probably be sufficiently purified by the currents of air passing in and out of the windows, for the purposes of comfort and salubrity; but if the number of persons be considerable, they will want additional ventilation both above and below. With closed windows, when the season will not admit of their being left open, the need of these ventilating openings becomes more imperative in proportion to the number of persons present for any time in the room; but with doors and windows sufficiently loose in their fitting to open and shut easily, there will always be some supply of fresh air from without, and some dispersion of warm and impure air from within, in proportion to the difference of temperature within and without, to assist materially the ventilation, and render the need of it less felt, when the persons in the room are but few in proportion to its size.

The more closely the doors and windows fit, the more large must be the ventilating openings, or instead of making them larger, artificial means of creating a current of air through them must be employed.

In the season of the year when it is most necessary to have doors and windows closed, artificial warmth is needed, and this supplies also a power for propelling a current of air through the ventilators. A common open fire-place, with a well constructed chimney, either for burning wood on the hearth, or coal in a grate a little elevated, is one of the best of ventilating apparatuses. It will answer a good purpose even without a fire whenever the room is warmer than the outward air, and from the low level of its opening, being generally even with the floor, or only slightly elevated, it is particularly fitted to carry off the lower air containing the largest quantity of carbonic acid gas. An opening into the flue of the chimney above the fire-place, and near the ceiling is the best situation for the upper ventilator, as it not only acts well there itself in favoring the escape of the warmer and lighter impure air, but by its transmission upwards increases the draft through the opening of the fire-place below. This opening however may be very much smaller than that below, and indeed if that below be large and the draft of air upwards through it good, it is but little needed unless when the number of persons in the room is considerable, or when numerous lights are burning.

But a free draft of air up the chimney cannot take place without an equally free admittance of fresh air into the room to take the place of that which ascends the chimney. If the room be tight so that no external air can enter by the sides, the chimney will have to serve for both currents, and there will be a column of cold air descending by the pressure of its superior density, and a column of warmer air ascending by its superior rarity. When the air of the room or of the fire-place first becomes warm, and presses upwards into the flue of the chimney already occupied by colder air, that air and the walls of the chimney which must be of the same temperature, will withdraw the caloric more or less from the warm air, thus condensing and cooling some portion of it which is then forced back into the room again with the descending cool air, and this process will go on, till the chimney has absorbed so much caloric from the warm air endeavoring to ascend, that its own temperature is raised so much, that it will be nearly that of the warm air, when it will cease porportionally to absorb so much caloric, and the air retain enough warmth to carry it up through the chimney freely. This explains why it is, that many chimneys smoke very badly when a fire is first kindled in the fire-place, and after a time, longer or shorter, cease to throw back the smoke into the room, and permit the fire to burn up clearly and brightly.

As the warm air that comes in contact with the sides of the chimney must necessarily lose more of its caloric, than that which is in the center, it seems to follow that the ascending current of warm air will occupy the centre of the flue, and the descending current of cool be distributed around its sides. In a room otherwise close, such ventilation would be very imperfect, as the action of cold external air on whatever part of the chimney was exposed to it, would be constantly counteracting the effects on the chimney of the ascending current of warm air within, by abstracting the caloric it imparted, and thus prolonging the struggle between the ascending and descending currents, and with the assistance, when the wind was high, of the pressure of a strong current of air above the opening of the chimney, preventing the warm air from rising freely into the atmosphere, and possibly occasionally eddying downwards into the flue, it would frequently succeed in forcing the ascending current back into the room. Hence many chimneys smoke badly in very cold and windy weather, that in calm and mild weather convey smoke readily, and hence a very hot fire is in such cases the most appropriate remedy, as giving sufficient force to the ascending current to overcome these obstacles.

But still in order that a fire may burn freely, and warm and impure air escape readily through a chimney, it is necessary that some supply of fresh and cooler air should have admission to a room through some other opening than the chimney, so as to leave that free for the ascent of the warm air, since if such an admission can be made below, this ascending current will soon fill the whole of the flue without material obstruction.

The usual and almost necessary inaccuracy of the joinings of doors and windows generally supply sufficient air for this purpose, but the cold drafts which they occasion are at least disagreeable, and often hurtful, and in cold countries, efforts are made to close these openings effectually by means of double windows and doors, listings, &c. In proportion however as these succeed the impurity of the air and the difficulty of making the fire burn increase, and some remedy for these is necessary. No remedy seems better than that recommended by Professor Hosking, but as was shown in the beginning of this article very long ago brought forward and practised by others, namely, the introduction into the room of fresh air sufficiently heated at least not to chill the room, and if necessary to assist in warming it or to warm it wholly.

But if we understand Professor Hosking's statement aright, it is proposed that the outward air brought into the hollow space around the fire-place shall be also applied to the purpose of supplying the air necessary for combustion, for the object as we understand him of preventing an up draught through the fire from the room itself, and of abolishing all illicit draughts, which we suppose means all currents of outward air entering through accidental and unavoidable chinks and cracks. Now if the fire could be wholly supplied by such means and all up draft of air from the room through it prevented, this would not abolish such draughts through these crevices, since he strenuously insists on a good ventilating opening near the ceiling into the flue for the escape of the warm impure air; and the passage of this from the room would favor the entrance of air through these crevices in proportion to its escape, unless the warm air thrown into the room from the sides of the fire-place should fully supply the demand. Moreover by this arrangement the impure and denser air at the lower levels of the apartment would have no escape provided for it, and would thus have a tendency to accumulate.

It would apparently be much better to have the fire as in ordinary cases depend wholly for its supply of air upon the general stock contained in the room, for as it would draw it principally from the lower levels, it would thus, while supplying itself with what would support combustion, heat, rarify, and send up the chimney, the impure or non-combustible portions mingle with it, and thus the carbonic acid, the worst of all, would be carried off as fast as formed, and if all the fresh air brought into the hollows surrounding the fire were thrown directly into the room there would be as little chance of "illicit draughts" as in his mode. The upper ventilator too would not need to be so large, and therefore less warmth would escape, and a better economy of fuel would be preserved.

A favorite mode of warming rooms of late has been that of conveying into them a current of fresh air heated over a furnace in the cellar or basement of the house, and conveyed by appropriate pipes into the different apartments where it may be required, generally through an opening in the floor provided with a register grate, against which the pipe abuts, and which serves to regulate the amount transmitted. Such rooms require ventilating apertures, communicating with a chimney flue for the escape of the impure air generated in the room. The warmth of the pure air issuing from the register is generally so great that it rises at once to the top of the room, bearing down under it the air of the room, and the less heated air of the respiration to a very considerable extent, while the naturally greater gravity of the air favors its descent. From this cause the lower body of air is the most impure as in other cases, only perhaps more decidedly so, and of course the need of a ventilating aperture on a low level is strikingly evident; yet we have seen in such rooms only one ventilator, and that placed just below the ceiling, as if to provide an escape for the warm fresh air just introduced, and to favor as long as possible the accumulation and retention of carbonic acid. If there be but one ventilator in a room so warmed it should be near the floor. Indeed a good opening in such a situation would probably answer all the purposes required, for the purest as well as the warmest air will be in the upper portion of the room, and if the lower air can be made to yield freely to its downward pressure, as it accumulates by being provided with a sufficient place of escape below, it will fill the whole room before, under ordinary circumstances, it can be rendered sensibly impure, and as fast as made so will be driven downwards and outwards by the continual fresh supply from the register.

With a stove of any of the varieties of what in its simplest form is termed a box stove, in which fire burns freely by the admission of a current of air from the room, and issuing through the funnel, there is a great economy of heat, but the ventilation is generally insufficient in a tight room, especially if a number of persons be present. Rooms so warmed ought to be provided with an additional ventilating aperture on a low level, and also with one on a high level for at least occasional use; and in order to make these properly effective, if the doors and windows be closely jointed or made impervious to the air in any considerable degree, a supply of fresh air should be brought in, and conducted to the stove in some convenient way, so as to be sufficiently warmed before being diffused into the room. The Pollock stove mentioned in the beginning of this article, was a good adaptation of this principle.

What are called *air-tight stoves*, which have been greatly used within a few years past, while they economize fuel greatly, and keep up a very equable temperature, are very faulty with regard to ventilation. They simply heat the air of the room, with scarcely any provision for its renovation in themselves, and will soon render a very tight room unendurably unhealthy, unless good ventilating apertures be made in the chimney, particularly in the lower level. The same may be said still more emphatically of a system of pipes conveying hot water or steam for the purpose of warming a room, and also for the German stove, the heated body of which is in the room, while the apertures for draught and for renewing the fuel are in an adjoining apartment or in a passage way.

In the case of stoves, a large surface radiating a moderate degree of heat is equally efficacious, in warming a room, with a smaller surface proportionally more intensely heated. This is a principle of some value when the stove is made of a material, iron for instance, which is capable of being readily oxydized; for in this case the high temperature promotes this process, and thus detracts from the life-sustaining properties of the air. The case is still worse, when the stove, as is often the case, is polished with a material containing any considerable quantity of carbon, as the high temperature will enable the oxygen more readily to effect a decomposition, and, uniting with the carbon, to form carbonic acid, a portion of which may be driven off into the room, and thus render the air of it, not only negatively, but positively, impure.

While on this subject we may as well mention another matter connected with the use of stoves. It has been a very general belief that they rendered the air very dry, and that it is proper, perhaps necessary, to obviate this dryness by placing upon the stove a vessel of water, by the evaporation of which a due degree of moisture may be imparted to the air.

The heat of the stove does not dissipate the moisture of the air, nor does it affect it otherwise than any other mode of imparting caloric merely to it. But warm air is capable of containing more vapor in solution than cool air, and hence will absorb it readily from other bodies containing it, and as under ordinary circumstances stoves warm a room more thoroughly and effectually than open fire-places, as they are generally constructed, the moisture of the walls and furniture is more quickly and completely withdrawn, so that *they* become drier; but not the air, which is really rendered more moist by the process. So also with the human integuments, whether external or internal, to which this warm air has access, thus producing a sensation of dryness on them. That this is prejudicial to health, unless the heat of a room exceeds the ordinary summer temperature in the day, is very questionable, that there is any benefit in supplying an unusual proportion of warm moisture to the air of a room in cold weather, at least as a general thing, is still more questionable; but to pursue the inquiry would lead to a train of considerations foreign to the present subject, and prolong this paper to far too great a length. It is sufficient perhaps to point out for the consideration of others the conclusion to which we incline.

Charlestown, N. H., March 16, 1852.

Art. XXXV.—*On the Diluvial or Quarternary Deposits in California;* by Professor James Blake, F.R.C.S., M.D., &c.

The extent of diluvial deposits in this country, and their importance as the principal source from which the future supplies of gold are to be derived, will I trust invest this imperfect notice of this geological and mineralogical formation, with sufficient interest to ensure it a place in your valuable Journal. The observations now brought forward were collected while making a geological examination of a portion of the state, during the last summer. To the general geological character of the country, it is not my intention at present to allude, except in so far as it is connected with the immediate subject of this paper.

With the exception of the diluvial strata, the whole geological formation of the Sierra range consists of igneous and metamorphic rocks: the former are mostly porphyritic in the lower hills, whilst higher up trachytic rocks are more frequently met with. The metamorphic rocks consist of micaceous schists, slates both talcose and micaceous, metamorphic sandstones, and limestones, with occasional beds of conglomerate. The stratified rocks have all been much displaced; it is rare to find them with a dip of less than 70°, and they are generally very nearly perpendicular. The strike of the beds in that section to which my observations have been confined (between the Stanislaus and Yuba rivers) is extremely uniform, being from 5° to 10° W. of N. and E. of S. The extent of the diluvial deposits is commensurate or nearly so, with that of the gold bearing region, in that part of the country which I have examined. They are found in a belt of land from thirty to sixty miles broad, and running parallel with the axis of the range; and from facts that I have ascertained from others, I have no doubt but that they exist throughout all the gold bearing region both north and south. These diluvial deposits are met with as we advance towards the lower hills of the Sierra, extending frequently some miles into the plain. They are often of considerable thickness, and frequently rest on tertiary rock. On approaching the foot of the lower hills, the conglomerate and gravel are found in greater abundance, the pebbles and boulders are larger and contain more of the heavier rocks. They are seen also covering extensive valleys or flats of many miles in extent, enclosed by low ridges of porphyry and slate which rise rather higher than the surface of these beds. On ascending from the lower hills towards the mountains, these diluvial beds no longer occupy the same relative position: occasionally deposits of rounded stones can be found in the valleys and on the sides of the hills, but when this is the case their origin can always be traced to deposits existing on the tops of the surrounding hills, from which they have been brought down by the action of causes now at work. As we ascend towards the axis of the chain, these deposits become more extensive, and at a distance of twenty or thirty miles from the lower hills, they are found occupying the crests of almost all the highest ridges in the country, but besides being found on the crests of the ridges, where their extent frequently does not exceed a few yards in breadth, they are also met with covering in the extensive elevated flats which exist on the benches between the different water courses, forming continuous beds of some miles in extent, which are rarely interrupted by the protrusion of any of the older rocks. Where found in these elevated situations, the lower hills and valleys are entirely free from them; frequently a large section of country will be enclosed between two high ridges capped by deposits and diverging from a common point; in the intervening space will be seen many secondary ridges, sometimes fifteen or eighteen hundred feet high, formed entirely of the older rocks, no traces of deposits being found on their surface, nor in the ravines that lead from them.

The depth of these deposits is extremely variable. Sometimes nothing more than a trace of them in the presence of a few round pebbles lying on the top of a ridge, is found; the valleys and ravines in the neighborhood containing their disintegrated elements in considerable quantities. In other instances, particularly where spread out over the elevated flats, they are of a moderate and pretty uniform thickness for a considerable distance, varying from two or three feet to a few inches, and this too in positions where the surface could not have been exposed to any great amount of denudation. They are again found many hundred feet in thickness, composed of superimposed strata of different mineralogical constitution, generally horizontal and conformable with each other.

The localities where these deposits are met with most extensively disclosed and that have been worked, are at Nevada and at Mokelumne Hill. At the former place they form the crest of a high mountain called the Sugar Loaf, full 2000 feet above the level of Deer Creek, the upper 600 feet being formed entirely of diluvial strata. At Mokelumne Hill they are also some 200 feet deep, forming here also the summit of a high and isolated mountain. The elements of which they are composed, differ considerably in different localities, although there are through the whole series many points of resemblance. In the lower valleys, and flats, between the ranges of the lower hills they appear to consist of beds of gravel, containing occasional boulders of quartz, and the harder rocks. On the elevated flats higher up in the mountains, the surface of these deposits is generally covered by a reddish loam, mixed with small gravel, whilst reposing on the bed rock, and a few inches above it, is found a stratum containing large boulders and gravel, the boulders being principally quartz. On the top of the hills and the crests of the ridges, where they generally attain their greatest thickness, we find them composed of many distinct strata lying nearly horizontal, and conformable with each other and generally also with the surface of the underlying rock. In these situations the most superficial stratum is composed of a mass of extremely hard conglomerate, containing principally trachytic rocks, imbedded in a hard argillaceous cement. It is this hard stratum that has undoubtedly preserved the underlying beds from the destructive influences which have so powerfully acted on the surrounding rocks. Beneath this stratum the deposits differ considerably in different localities. At Nevada and Mokelumne Hill there are found extensive beds of white and blue clay, containing particles of quartzose sand, and occasionally a few small pebbles. At other points, the clay is entirely absent, and the whole series consists of beds of conglomerates and soft friable sandstone. In the lower strata quartzose conglomerates with an argillaceous cement, or loose quartzose gravel, always prevails, with large boulders of quartz weighing frequently two or three tons, having their surface worn smooth, and the angles rounded. The deposits of these heavier rocks have been formed on spots which were evidently lower than the level of the surrounding rocks, whilst on those parts which were higher at the time the deposits were formed, the higher trachytic rocks are found. As far as my researches have extended, the more quartzose conglomerates have been invariably found on the erupted rocks, whilst the stratified rocks which they had upheaved were only covered in by the trachytic conglomerates. The pebbles of which these conglomerates are composed present specimens of all the harder rocks. Metamorphic sandstones, clinkstone, trap porphyries and quartz make up the larger part of the mass. They are all perfectly rounded but in the lower deposits are so soft, that with the exception of the trap and quartz, they generally fall to pieces on exposure to the air. The strata as before observed are nearly horizontal and conformable; if they have any dip, it appears to have been owing to the slope of the surface of the rock on which they were deposited; in fact no displacement seems to have taken place in the country since the period of their formation. They lie perfectly horizontal over the almost vertical edges of the upheaved slate rocks.

Pieces of half carbonized wood, and impressions of leaves are sometimes found in the clayey beds of these deposits, and at Nevada it is said that the trunk of a tree had been traced for some distance in the clay, at about forty feet below the surface. I have obtained specimens of wood and also imperfect impressions of leaves taken out four or five hundred feet below the surface of the ground, and three hundred and fifty feet from the side of the hill, at the same locality. The wood belongs to one of the Coniferæ, but I was unable to determine the character of the leaves. A tooth also has been found in some of these deposits. I have not seen it, but from description it would appear to be a bicuspid belonging to some large Pachyderm. The surface of the rock on which they repose, generally presents evidence of considerable abrasion, but I have been unable to detect any regular grooves in it. Where it is more elevated it has been less worn, some of the edges of the slates being not much broken. As regards their age there can be but little doubt that they belong to a comparatively recent period. They were evidently formed subsequently to the convulsions which upheaved the older stratified rocks and in fact there appears to be no evidence of any geological disturbance since their deposition except in the simultaneous elevation of the whole country or in the recession of the ocean. But the most important questions connected with these deposits both under a scientific and practical point of view, are the extent of surface occupied by them at the time of their formation, and the direction of the currents that carried the materials they contain into their present position. From the relative level at which these deposits are found, from the analogous nature of their mineralogical constituents over extensive surfaces of country, and from the fact that there is no evidence of their having been subject to the action of any local upheaving agencies, we may conclude that the whole of the district through which they are now seen in situ, must have formerly formed the bed of an ocean, the bottom of which must have been on a level with the tops of the highest ridges at present existing in the country, and that the deep and precipitous valleys which now run between these ridges must have been worn out by the action of water, either rushing in strong currents from the interior of the country, or else by the disintegration and denudation of the rock by the slow process of atmospheric agencies, or as is most probable, by both of these processes combined.

As regards the direction of the currents by which these masses of rolled rock were brought into their present position, I have not been able to form any decided opinion from the character of the pebbles, although the metamorphic sandstones have never been observed in situ so low down as where these deposits are found, and in which they exist in considerable quantities, but on account of the country beyond the mining regions being inhabited by hostile Indians it was impossible to follow the traces of these deposits so far towards the axis of the ridge as I would have wished. One or two facts however have presented themselves which would indicate that the direction of the currents at the locality where these facts were noticed, was from the northeast. At a short distance from Coon Hollow is a hill, the present surface of which is about on a level with the rock on which the diluvial deposits rest. The crest of this hill is formed by a large vein of quartz almost vertical, and running N.W. and S.E. On the east side of this ledge, the slates which compose the body of the hill, are found rising to the surface of the ground, on a level with the top of the ledge. On the other or west side of the ledge the slate has been washed out or at least removed, to the depth of about twenty-five feet and the hole thus formed has been filled in with the diluvial deposit, amongst which however are found many masses of quartz perfectly angular, and which undoubtedly came from the vein. There were also layers of quartzose breccia mixed with these deposits. The formation of this cavity on the southwest side of the vein would be produced by a current from the northeast, washing out the rock on the farther side of the obstruction. Another similar instance occurs near the same spot, where the rock, a clay stone, has been washed out to some extent on the southwest side of a barrier caused by a dyke of harder porphyry.

I have also been informed by the miners, that gold is found in greater quantities on the east side of the elevations in the bed rock, a fact that would indicate that the current from which it was deposited, came from that direction. There were however frequent periods in which the ocean must have been almost still, when its waters deposited the extensive strata of clay and sand that are found interstratified with the conglomerates.

The principle geological interest attached to these diluvial deposits is the evidence they afford of that portion of the mountain chain on which they are found having been the bottom of an ocean at a comparatively recent period, and also that it must now be many ages since the country has been the seat of any great disturbance. The elevation they here attain (probably four thousand feet above the level of the ocean) would indicate a considerable rise in the level of the land on this part of the continent. A more extended examination will undoubtedly identify them by their organic remains, with the diluvial drift found on the eastern portion of the continent and which is so extensively developed in South America along the eastern slope of the Andes. The origin of these deposits or the locality from which they have been brought, presents a question of great interest both to the geologist and also to the miner, for on its solution most probably depends the discovery of a region where auriferous quartz must exist in large quantities. Many of the localities in which they are at present found, abound in veins of auriferous quartz, and it is possible that the gold which these deposits contain, has not been carried far from the spot where it was originally thrown up; but the great abrasion that large boulders of the hardest rocks have been submitted to, evidently indicates that they at least must have been carried a considerable distance by powerful currents, and it is probable that the gold has been brought with them. Should they have come from the higher mountains to the east, rich gold-bearing veins must be found in this direction. This portion of the country however yet remains to be explored.

As regards the mineral riches of these deposits, it would appear that gold is found wherever they exist. The ravines coming from the ridges on which they are found are generally extremely rich and always contain gold, even in places where the deposits themselves have been worked without success: in some places where they have been worked, as much as thirty thousand dollars have been taken from a claim of fifteen feet square, and there are many instances where ten and fifteen thousand dollars have been taken out from claims of the same size. But few of these rich spots have up to the present time been opened, yet there can be no doubt but that many still remain to be discovered. Where these deposits are found extending over a large surface on the elevated flats, gold is always met with, generally diffused through the gravel immediately above the rock on which they rest, which yields from fifteen to forty cents to the 100 lbs. of dirt. There are spots where acres of these deposits have been turned up, in which the gravel never contains less than fifteen cents to the 100 lbs., and generally more. In the valleys in the lower hills, and even on the plains to the west of them where they are extended over vast tracts of country, these deposits are still auriferous, the gold being very generally diffused, and found in greater quantities the deeper they are worked. At present they will not pay for working, owing to the distance from water, and from the high rate of wages. In one place, where water could be readily obtained, a portion of these deposits situated to the west of the lower hills has been worked, and has been found to yield from five to thirty cents to 100 lbs. of earth, through an extent of 150 acres, the soil being found richer the deeper it is worked.

The above facts as to the quantity of gold found in these diluvial deposits are sufficient to prove that they must be the chief source from which the gold found in the country has been derived. Some undoubtedly has been set free by the gradual disintegration of the rocks containing auriferous quartz, but this can afford but a small quantity in comparison with the treasures that must have been spread over the bottom of the ocean that existed when the alluvial deposits of the upper hills were formed. And when we consider the extreme richness of many parts of those small portions of its bed that still remain in situ, and then attempt to form an estimate of the treasures that must have formerly existed in it when it occupied many thousand times the space that is now covered by the deposits that have yielded all the gold already taken from the country, we are led to the conclusion that much more extensive deposits of gold must exist in California than any that have yet been worked. These deposits are undoubtedly to be found in the diluvium in the lower valleys and on the plains at the foot of the mountains, and will afford a supply of gold that it will take centuries to exhaust.

Sacramento, Jan. 15, 1852.

ART. XXXVI.—*Two New Minerals from Monroe, Orange Co.*; by CHARLES UPHAM SHEPARD, M.D.

1. *Dimagnetite.*

PRIMARY form, right rhombic prism, M : M = 130°, (common goniometer). Crystals in elongated prisms, with smooth, or but faint longitudinal striæ. Color iron-black. Lustre of faces feeble. Cleavage parallel with M, and traces also with the shorter diagonal. Fracture conchoidal to uneven, attended with imperfect metallic lustre. Opaque.

H. = 5·5 . . . 6·5. Gr. = 5·789 (on a single trial of about 2 grains weight). Magnetic with polarity.

Before blowpipe, conducts like magnetite, with which species, it is probably identical in composition.

It occurs implanted upon crystals of magnetite. The longest crystals observed measure about 1½ inches. They sometimes manifest a tendency to composition, after the manner of staurotide.

The name is applied out of regard to the now supposed dimorphic character of $\dot{\mathrm{Fe}}\,\dddot{\mathrm{Fe}}$.

2. *Jenkinsite.*

Primary form, probably a rhombic prism. Occurs implanted upon massive magnetite and dark green pyroxene, forming velvety coatings, usually thin and even, but sometimes rising into irregular columnar (subfibrous) masses, one-third of an inch thick, somewhat resembling certain drusy varieties of arragonite. Its general appearance however is more strikingly that of the Cornish skorodite, which it resembles in its blackish green color, though it often has a shade also of olive, and when powdered, of pistachio-green. Lustre vitreous, feeble. Translucent.

H. = 2·6. G. = 2·4 . . . 2·6. Before blowpipe emits moisture, immediately blackens; and becomes strongly magnetic. When the heat is strongly urged, it melts into a dull black globule at the end of thin fragments. With borax, gives a glass stained by iron. Easily soluble in aqua regia, with separation of silica. It contains no alumina, (alkalies were not sought for); and consists of silica, peroxyd of iron, magnesia and water.

As a species it will stand, both chemically and mineralogically, near to the picrosmine of Engelburg, Bohemia.

It is from the same locality with the dimagnetite; and is named after Mr. John Jenkins, of Monroe, to whose kindness I am indebted for the specimens of both, and to whom mineralogists owe many interesting substances which he has brought to light in his vicinity.

Charleston, Feb. 23, 1852.

ART. XXXVII.—*On the Determination of Phosphoric Acid by Molybdate of Ammonia;* by WM. J. CRAW, Assistant in the Yale Analytical Laboratory.

[Read before the Berzelian Society of Yale College, March 30th.]

THE determination of phosphoric acid has always been one of the most important, and most difficult, problems of analytical chemistry. It is very widely diffused in nature; occurring in the soil, the ashes of plants, and a great number of minerals. The bases with which it is most frequently united, are, iron, alumina, the alkalies and alkaline earths. Several of these combinations are decomposed with very great difficulty, the phosphate of alumina, in particular, resisting nearly every effort to reduce it to its component parts.

Although good methods have been proposed for the analysis of many of the simple phosphates, that of phosphate of lime, for instance, yet it usually happens, that several of these occur together, and, until very recently, no process has been devised which could effect the separation of phosphoric acid from all the bases previously mentioned, when in company.

A great amount of labor has been spent by chemists, within the last few years, in the effort to overcome this difficulty. Numerous ways have been tried with greater or less success, but most of these contain inherent difficulties, which in many cases, prevent their application. Even Rose's process by carbonate of baryta, though a standing monument of profound knowledge and admirable research, is yet too complicated to yield good results, except in the hands of those who have practiced it so often as to be perfectly familiar with all the necessary precautions.

The great desideratum of a simple and accurate method for the determination of phosphoric acid, with whatever substances it may be combined, has been supplied by Sonnenschein.* He states that the yellow precipitate produced by molybdate of ammonia in the solution of a phosphate, contains phosphoric acid as an essential constituent, and not, as asserted by Svanberg and Struve, an accidental admixture. From several analyses of this compound he finds it to contain about 3 p. c. of phosphoric acid. A number of trials were also made to ascertain whether by this means phosphoric acid could be separated and determined quantitatively, which were completely successful. For this purpose a large quantity of the molybdate solution is prepared as follows: 1 part of molybdic acid is dissolved in 8 parts of ammonia and 20 of nitric acid. The phosphate is dissolved in nitric acid and there is added to it a quantity of molybdic acid equal to about 30 times that of the phosphoric acid. The solution with

* Vide Erdmann's Journal für Prak. Chem., vol. liii, p. 339.

the precipitate is digested for some hours with the aid of a very gentle heat, filtered and washed with the same solution, which was used for the precipitation. The whole is then dissolved in ammonia, and the phosphoric acid thrown down by a magnesian salt. The presence of molybdic acid is not injurious, as the double molybdate of ammonia and magnesia is easily soluble.

Sonnenschein's experiments on the separation of phosphoric acid from alumina and other bases, all gave very good results.

With the view of confirming this discovery, and also of ascertaining with more precision the cause of the peculiar behavior exhibited by this substance towards reagents, I have made a number of trials with it. Among other substances, the action of the mineral acids and of the ammoniacal salts, has been more particularly tested.

The yellow powder is found to be

In chlorid of ammonium, - -	easily soluble.
Oxalate of ammonia, - -	" "
Sulphate " - -	sparingly "
Nitrate of potash, - -	" "
Chlorid of potassium, - -	" "
Sulphate of magnesia, - -	" "
Nitrate of ammonia, - -	very little "
Sulphate of potash, - -	soluble.
Sulphate of soda, - -	"
Chlorid of sodium, - -	"
Chlorid of magnesium, - -	"
Sulphuric acid, strong and dilute,	"
Hydrochloric " " "	"
Nitric " " "	"
Hot water, - - - -	"

In all these cases the mixture was heated to boiling. Solutions of the caustic alkalies and the alkaline carbonates and phosphates dissolve the yellow compound even in the cold. So also do chlorid of ammonium and oxalate of ammonia. The mineral acids also act upon it to some extent. Cold water dissolves it with great difficulty. It appears to be decomposed, to a small extent, by the combined influence of air and moisture, as it turns blue when dried in the atmosphere after washing with water. Its behavior towards solvents is changed by the presence of molybdate of ammonia, so that it becomes nearly insoluble in acids, even on boiling. The act of solution is, probably, in all cases, attended with decomposition and removal of molybdic acid, which is prevented by the presence of molybdate of ammonia.

Some quantitative experiments were also made on the separation of phosphoric acid from the bases. It may be important to remark, that, when effecting the precipitation by means of molybdate of ammonia, this, as well as the nitric acid, should be in decided excess. To ascertain when this is the case, before filtering off the solution, a drop of it may be taken up with a pipette and transferred to a test tube containing solution of sulphuretted hydrogen, when the brown precipitate of sulphuret of molybdenum will appear.

After separating the precipitate from the solution, the latter should always be allowed to stand for some time in a warm place to see whether any additional precipitate is formed.

TRIALS.

I. Taken 0·1199 gramme of tribasic phosphate of soda, which was dissolved in nitric acid, a pure solution of lime added, and the phosphoric acid determined according to the directions already given.

		Calculated.		Found.
$\overset{\cdots}{P}$	- -	0·0238	- -	0·0243

II. Taken 0·069 gr. of phosphate of soda and mixed with solutions of iron, alumina, lime, magnesia and potash; the phosphoric acid then determined as before.

		Calculated.		Found.
$\overset{\cdots}{P}$	- -	0·0137	- -	0·0146

III. Taken 0·0463 gr. of phosphate of soda, mixed with solutions of the same substances as in the last, and the phosphoric acid determined in the same manner.

		Calculated.		Found.
$\overset{\cdots}{P}$	- -	0·0092	- -	0·0095

These results confirm those of Sonnenschein, and show that the method, as regards accuracy, is all that can be desired, while, in point of simplicity, it is superior to any of the old processes.

It will prove of especial advantage in cases, where, as in the analysis of soils, a small quantity of phosphoric acid is associated with a variety of other substances existing in much larger proportion.

New Haven, March, 1852.

ART. XXXVIII.—*On the Eruption of Mauna Loa in* 1851; from a letter to Rev. C. S. Lyman, by Rev. T. Coan, dated Hilo, Hawaii, Oct. 1st, 1851.

I have wasted several days hoping to get more definite and reliable information respecting a recent volcanic eruption. Some facts are before me and these allow me to communicate, promising that, should anything new and important come to hand on the subject you may expect to hear again.

On the 8th of August last, a new eruption was seen on the western slope of Mauna Loa, a few miles from its summit.

All we could see at Hilo, was a white pillar of smoke by day and a brilliant fiery pillar by night. Owing to a canopy of clouds which, much of the time, shrouded the mountain, we obtained only occasional views of the eruption. At Kau the view was less obstructed. The rising columns of light and smoke, as seen from some points in that district, were said to be gorgeous and glorious. A gentleman then surveying in Keaiva—of notorious and impressive memory—tells me that the light at that place was sufficient to enable him to read in the night. He also asserted that he heard several distinct detonations from the mountain during the eruption, like the explosion of gases and the rending of rocks. This would be remarkable, as the distance to the point of eruption must have been thirty or forty miles. But the most magnificent scenes were witnessed on the western side of the mountain, in the district of Kona. Enormous floods of rock in igneous fusion burst from an orifice supposed to be about five miles westward of Mokuaweoweo, the great crater where Captain Wilkes encamped, and rolled down the western slope of the mountain towards Kaawaloa in a stream from one to two miles wide, and, perhaps, ten miles long. You will, however, receive these statements as matters of opinion and conjecture and not of actual observation and exact measurement.

Two gentlemen ascended the mountain from Kaawaloa until they reached the point where the stream terminated; but they did not explore the stream to its source, or to the terminal crater from whence it flowed. This is to be regretted. Had I been on that side of the island I should, probably, have given it a thorough exploration, ascertaining its average breadth and depth, the distance and direction of the flow, the angle of declination down which it rolled, and the size and location of the crater from which it was erupted. The eruption continued but three or four days, and we had hardly time to admire its brilliant corruscations and its rousing demonstrations, before all was hushed in profound silence and covered with a pall of darkness. Notwithstanding the intense motive for a visit to those lofty, wild, and chaotic regions is weakened, still, I cherish a desire, a hope and a *purpose*, once more to climb those rugged and laborious heights, and to explore the recent volcanic wonders in those untrodden solitudes.

Two gentlemen, Mr. Sawkins, an English artist, and a Mr. Grist, graduate of Yale, left Hilo ten days ago for Kilauea and Mauna Loa, and they are, probably, on the summit of the mountain to-day. Their object is to visit and sketch the late eruption, and from thence make a direct descent to Kailua or Kaawaloa. I expect to hear from them in a few days, and hope for something more definite when they shall have reported.

As for old Kilauea, it remains much as when I last wrote you. The whole pit and all the banks resemble a vast area of smouldering ruins. Smoke and steam are constantly issuing from the ten thousand nostrils of the old fire goddess, but Pele seems in a state of steaming stupefaction. An occasional gleam of light flashes from her half opened eyes. No lake of fusion has been opened since my last letter, and no important changes have taken place in the great dome, the cones, the ridges of debris, and in the general internal area of the crater. No sympathy has been noticed between Kilauea and the late mountain eruption.

ART. XXXIX.—*Notice of some large Trees in Western New York;* by S. B. BUCKLEY.

THE large trees in Western New York are fast disappearing, before the demands of civilization which annually destroy thousands. Nor is man their only enemy. Many die from the wounds inflicted by insects, especially the white oaks (*Quercus alba*,) thus compelling their owners to cut them down and adapt them to present use instead of preserving them for the benefit of posterity. The time is not far distant when Genesee flour will be carried to market in sacks because staves cannot be obtained sufficient to make the barrels.

The following is a sketch of a few of the large trees yet remaining. Of these, the "Big Tree" near Geneseo is the most worthy of attention. It may be well to remark that it is said that many years ago there was a black walnut (*Juglans nigra*) on the Genesee river which was 16 feet in diameter. Its trunk was hollow and was sometimes used as a temporary dwelling. It is certain that a large tree on the Genesee river near Geneseo attracted the notice of the early settlers of western New York. One of their first roads leading from Canandaigua to Geneseo, via the foot of Honeoye lake was long known as the "Big Tree road." In volume second of the Documentary History of the State of New York is a map of Western New York, published in 1809, on which the "Big Tree" is laid down as being on the Genesee river. The native Indians had long known this corpulent giant of their woods and named one of their chiefs the "Big Tree" or "Great Tree." A section of this tree was conveyed to New York via the Canal and Hudson river about 15 years ago where it was used as a grocery.

There is a big tree still alive (July, 1851) on the banks of the Genesee river, about a mile from the village of Geneseo. It is a swamp white oak, (*Quercus bicolor*, Wild.) At the height of about 20 feet its body sends forth numerous large branches, many of which are now dead. The trunk varies little in size from the ground to the branches, it having an average circumference of 27 feet. Its smallest circumference is 24 feet. An elm tree three feet in circumference is partly joined with it; their bodies often touching and their limbs intertwining, the green leaves of the elm make the old oak look healthier and fresher than it really is. They are situated in a pasture and the ground is bare and hard beneath them from the tramping of cattle and visitors. The "Big Tree" seems fated soon to die. I knocked a few botanical specimens from its green branches and left regretting that all its limbs were not alive.

The swamp white oaks are numerous and often attain great size on the Genesee Flats. As examples, one is 14 feet in circumference; another, 13 feet 9 inches; a third, 12 feet 8 inches. The wood of this species is said to be superior to that of the common white oak. Many of these majestic trees contain more solid feet than the "Big Tree" on account of their greater height. The country is greatly indebted to the good taste of the Wadsworths who have left groups of noble trees standing in their meadows and fields.

I have recently (Feb., 1852) visited the lumber region in Alleghany county, New York, where a large portion of the hills and valleys are still covered with dense forests, through which the white pines (*Pinus strobus*) are conspicuous for their great size and height. I measured one which was 15½ feet in circumference at the height of 4 feet. One stump was 5 feet in diameter, another 4½ feet. A saw log 4 feet in diameter by its annular rings showed an age of about 210 years. The largest log which I could learn of ever having been at any one of the mills was one sawed several years since, 7 feet in diameter. A plank from this log containing 600 feet board measure was exhibited at the county fair at Angelica. I saw a hemlock (*Pinus canadensis*) which was 12½ feet in circumference.

In the history of New Hampshire by Belknap, a white pine is mentioned which was 7 feet in diameter. Michaux in his Sylva states that he saw a stump in Maine more than 6 feet in diameter. He also measured two trunks that were felled, one was 154 feet long and 54 inches in diameter, the other 142 feet long and 44 inches in diameter. I quote the above to show that no part of the United States can probably boast of larger white pines than Alleghany county.

An elm (*Ulmus americana*) was cut down during the present winter on the farm of S. K. Jones, near Dresden, Yates county, New York, whose stump is 4 feet 10 inches in diameter at the height of 4 feet from the ground. At the height of 15 feet the trunk was 15½ feet in circumference. At the height of 20 feet where the trunk divided into two large branches the circumference is still greater. Its height was about 60 feet. Its annular rings indicate an age of about 300 years. Owing to a slight decay they cannot be counted with exactness.

There is or was, a few years since, an elm a little more than 33 feet in circumference, standing about a mile from the village of Auburn in this state. It was a few rods from the turnpike. It attained quite a celebrity and was long known as the "big elm."

In the township of Sodus, Wayne county, are many large sycamores (*Platanus occidentalis*), several of which are from 14 to 16 feet in diameter. The largest of them are uniformly hollow. These trees are not far from Lake Ontario and their branches still appear to be in a flourishing condition. Most of the trees named in the foregoing article grew in a rich deep alluvial soil; even the large pines were either in ravines or valleys.

Art. XL.—*On Lettering figures of Crystals;* by James D. Dana.

A concise method of lettering figures of crystals so that the exact positions of the planes with reference to the axes shall be indicated, would, if adopted, aid much the student in comprehending the subject of crystallography, and give him almost without effort an insight into its mathematical department. The modes which have been proposed lack both conciseness and simplicity, and have not been generally received. The plan here brought forward is an abbreviated method of transferring to the crystal the parameters of the planes, corresponding essentially to the symbols of Weiss and Naumann, and it appears to answer fully the end in view.

As the general character of Naumann's symbols is explained in the author's Treatise on Mineralogy,* the reader can refer to that work for information, if not familiar with the subject. We merely add that the planes are expressed by a ratio indicating their position with reference to the axes, as $1:1:1$, $2:1:1$, $4:2:1$, $6:3:2$, or in general terms, $m:n:r$, the first figure referring to the vertical axis (axis a), and the others to the lateral (b and c); $6:3:2$, or $6a:3b:2c$, signifying that the plane so designated, referred to the three axes, meets (or would meet if extended) the vertical axis at a distance $6a$, one lateral at a distance $3b$, and the other at a distance $2c$, or in this ratio.

In these and all such ratios, one term may always be a unit (e. g. $6:3:2=3:\frac{3}{2}:1$,) and the general expression $m:n:r$, hence becomes $m':n':1$, or $m':1:r'$. Consequently, if two of these terms be expressed, the complete ratio will be fully indicated.

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* First edition, 1837, and Third edition, New York, 1850.

Thus the ratio $m:n:1$ is sufficiently indicated by the expression $m:n$, and $m:1:r$, by $m:r$; or if we use the long and short mark ($^-$ and $\smile$) to distinguish the longer and shorter lateral axes, $m:n:1$ may be indicated by $m:\bar{n}$ and $m:1:r$ by $m:\breve{n}$. If the lateral axes are equal (as in dimetric forms) this distinction is unnecessary and $m:n$ is a general expression for all planes, the third term, a unit, being understood though unexpressed. Naumann writes these expressions by placing m before a letter P, and n after the letter; thus the ratio $m:n$, corresponds to mPn. So in his system—

$1:1:1$	corresponds to	$1:1$ or P,*
$2:1:1$	"	$2:1$ " 2P
$4:1:1$	"	$4:1$ " 4P
$4:2:1$	"	$4:2$ " 4P2
$\infty:1:1$	"	$\infty:1$ " ∞P
$\infty:2:1$	"	$\infty:2$ " ∞P2
$\infty:\infty:1$	"	$\infty:\infty$ " $\infty P\infty$

Or in the trimetric system, in which the lateral axes are unequal,

$4:2:1$	corresponds to	$4:\bar{2}$ or $4\bar{P}2$
$4:1:2$	"	$4:\breve{2}$ " $4\breve{P}2$
$\infty:\infty:1$	"	$\infty:\bar{\infty}$ " $\infty\bar{P}\infty$
$\infty:1:\infty$	"	$\infty:\breve{\infty}$ " $\infty\breve{P}\infty$

But farther explanations of the system are hardly necessary, as they will be found elsewhere.

In abbreviating this system of notation for the purpose of lettering crystals, I propose simply *to drop the P* of Naumann's symbols, which is in fact a useless letter, and *to write in place of the symbol* ∞ (*infinity*) *the letter O.* The brevity thus attained makes the system available, for lettering even complex figures, examples of which are here given.

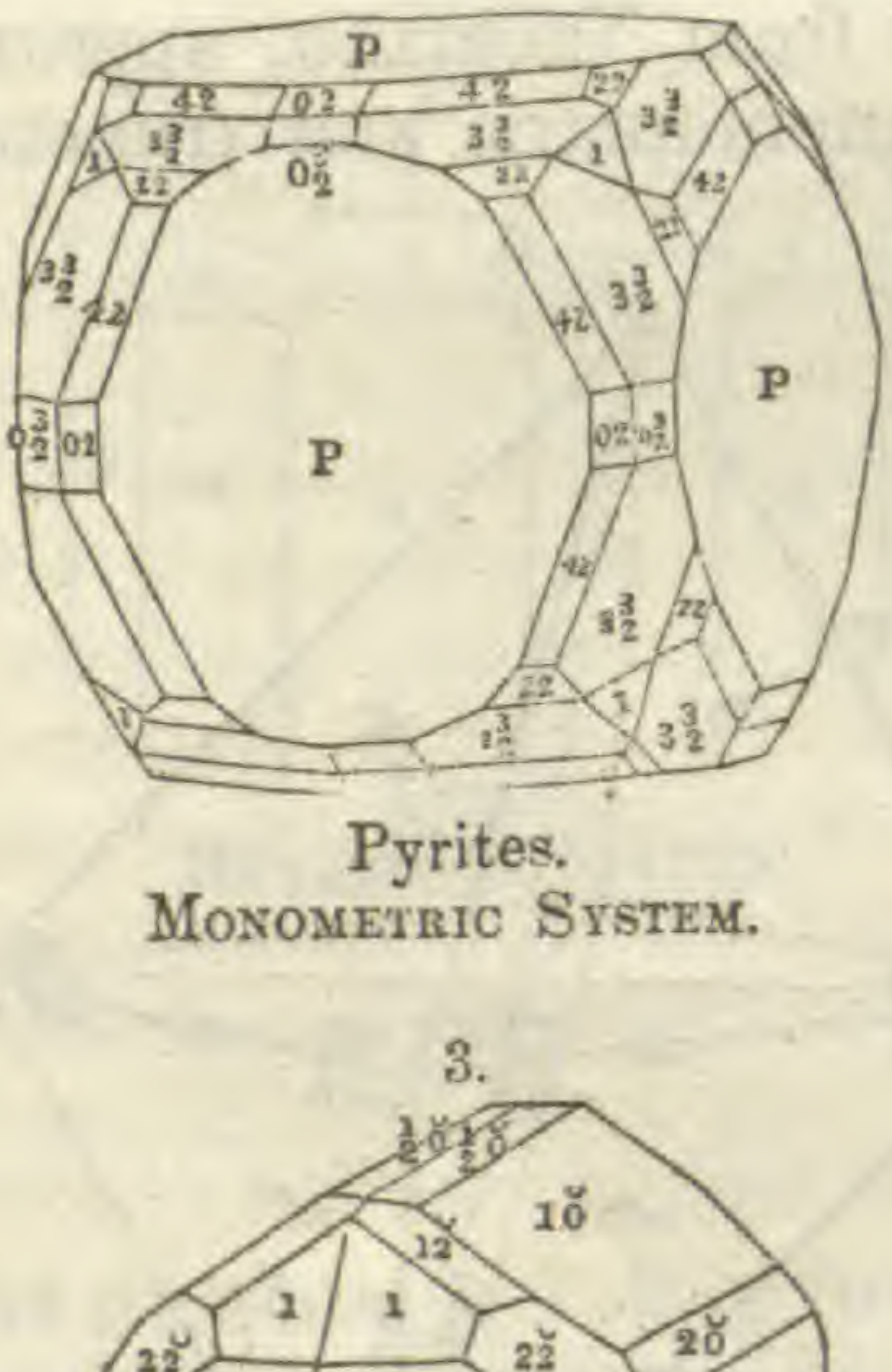
Thus in figure 2, the three planes 1, 2, 4, are 1P, 2P, 4P, of Naumann's system, equivalent to $1:1:1$, $2:1:1$, $4:1:1$.—The plane o, is ∞P or $\infty:1:1$.—The plane o-o is $\infty P\infty$, or $\infty:\infty:1$. The plane 2-2 is 2P2 or $2:2:1$.—The plane 3-3 is 3P3, or $3:3:1$.—The plane 1-o is $P\infty$ or $1:1:\infty$.—The plane 4-2 is 4P2 or $4:2:1$. Remembering that the first figure refers to the vertical axis, the zones of the planes are easily read off. The vertical series 1, 2, 4, o, represent forms with an increasing vertical axis, $1a$, $2a$, $4a$, ∞a, a standing for the normal length of the axis in a given species. The planes 2-2, 4-2, o-2 form another zone, in which the vertical axis increases from $2a$ to $4a$ and then

* The units are omitted in this and other cases as unnecessary.

to infinity, while the ratio between the lateral axis is constant (2 : 1). And with the crystal before the student, he might at once perceive the truth of the general law that in such a series, that is, with the 2nd ratio constant, the mutual intersections of the planes in the series are parallel and horizontal. The zone 2-2, 3-3, 4-4, exhibits the relations of planes in that oblique series, the general formula being *m-m*, or *mPm* in Naumann's system. The zone o, o-2, o-3, o-o, is a horizontal zone, with the vertical axis infinite, the planes being parallel to this axis, 4, 4-2, 4-4, 4-4, 4-2, 4 lie in another series, the mutual intersections being parallel, since in each the vertical axis equals $4a$, (4 being the first figure in the lettering of each plane.) In this system and all the others, the terminal plane is conveniently designated by P. It is 0P of Naumann, the vertical axis being considered as zero.

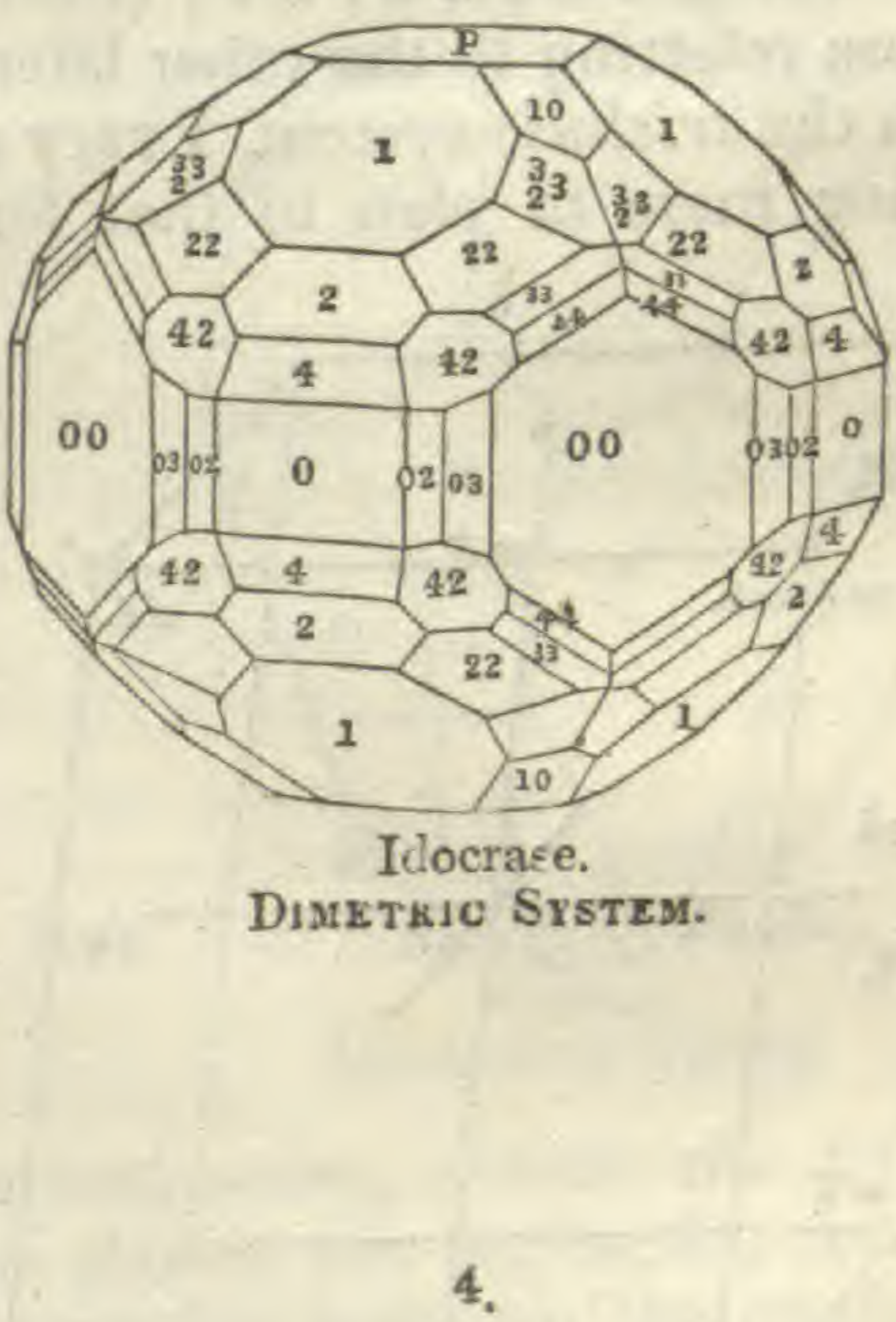
In figure 3, of the *trimetric system*, as the lateral edges are unequal, the figures that refer to the shorter axis have a short

1.



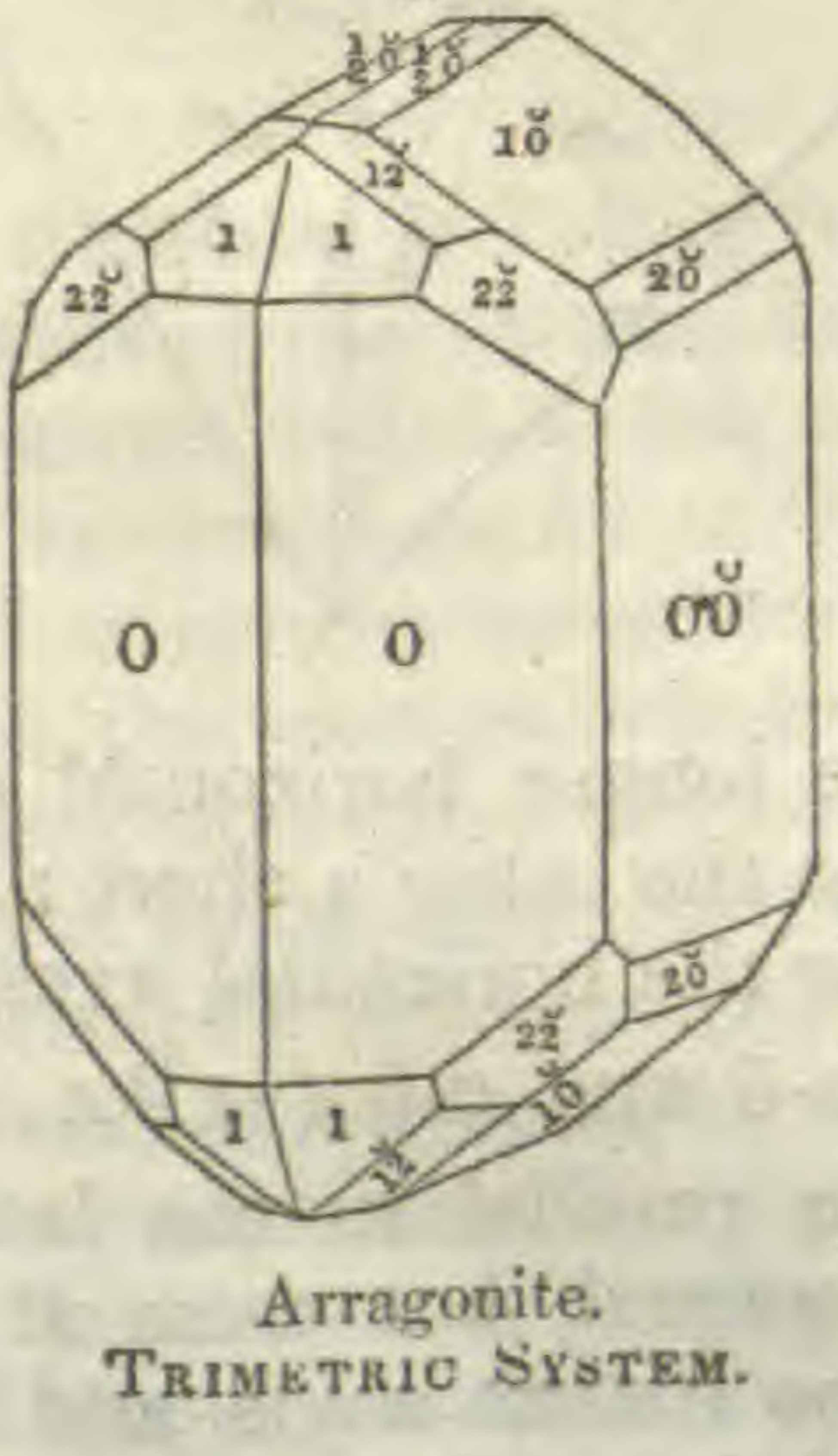
Pyrites.
MONOMETRIC SYSTEM.

2.



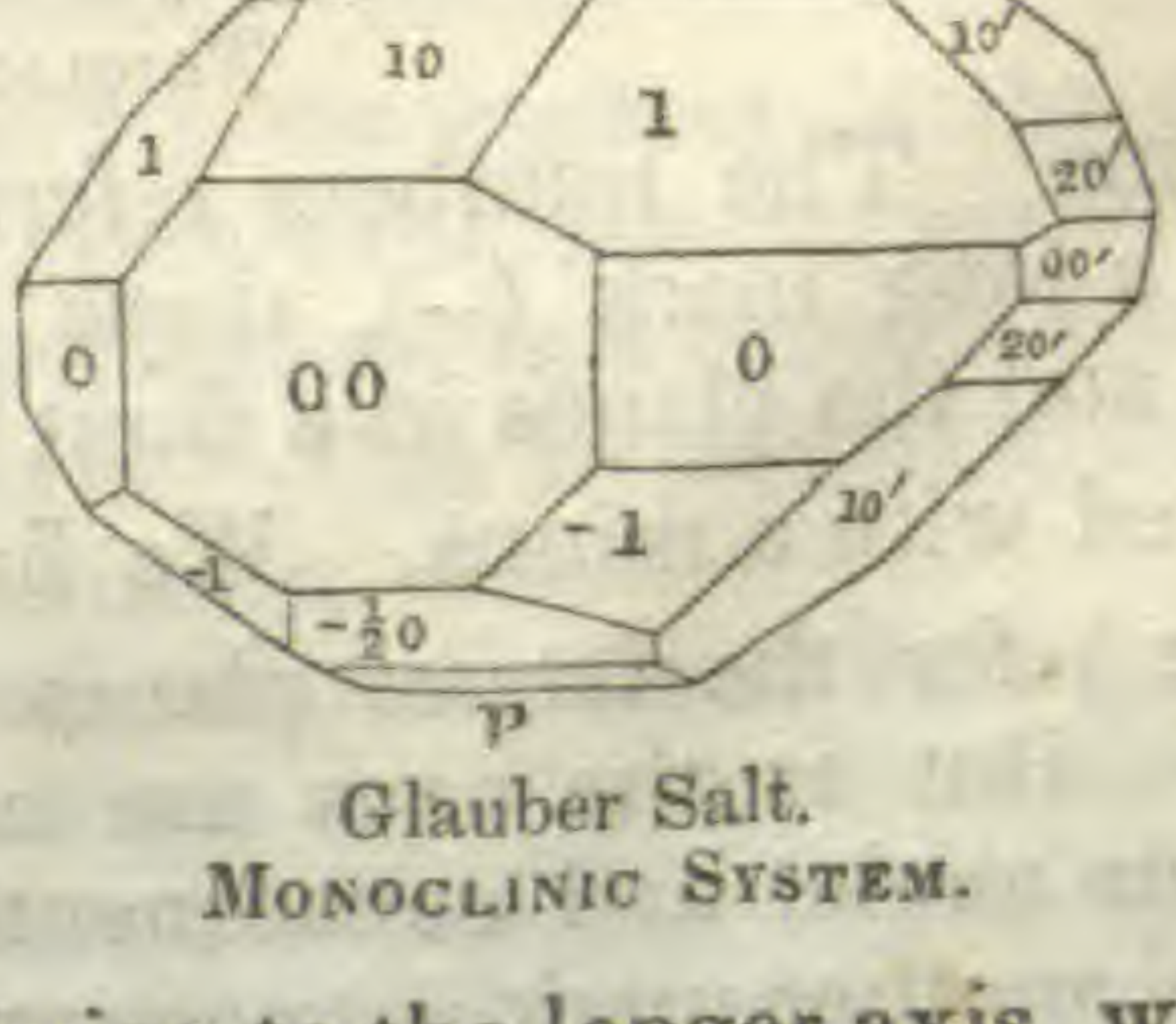
Idocrase.
DIMETRIC SYSTEM.

3.



Arragonite.
TRIMETRIC SYSTEM.

4.



Glauber Salt.
MONOCLINIC SYSTEM.

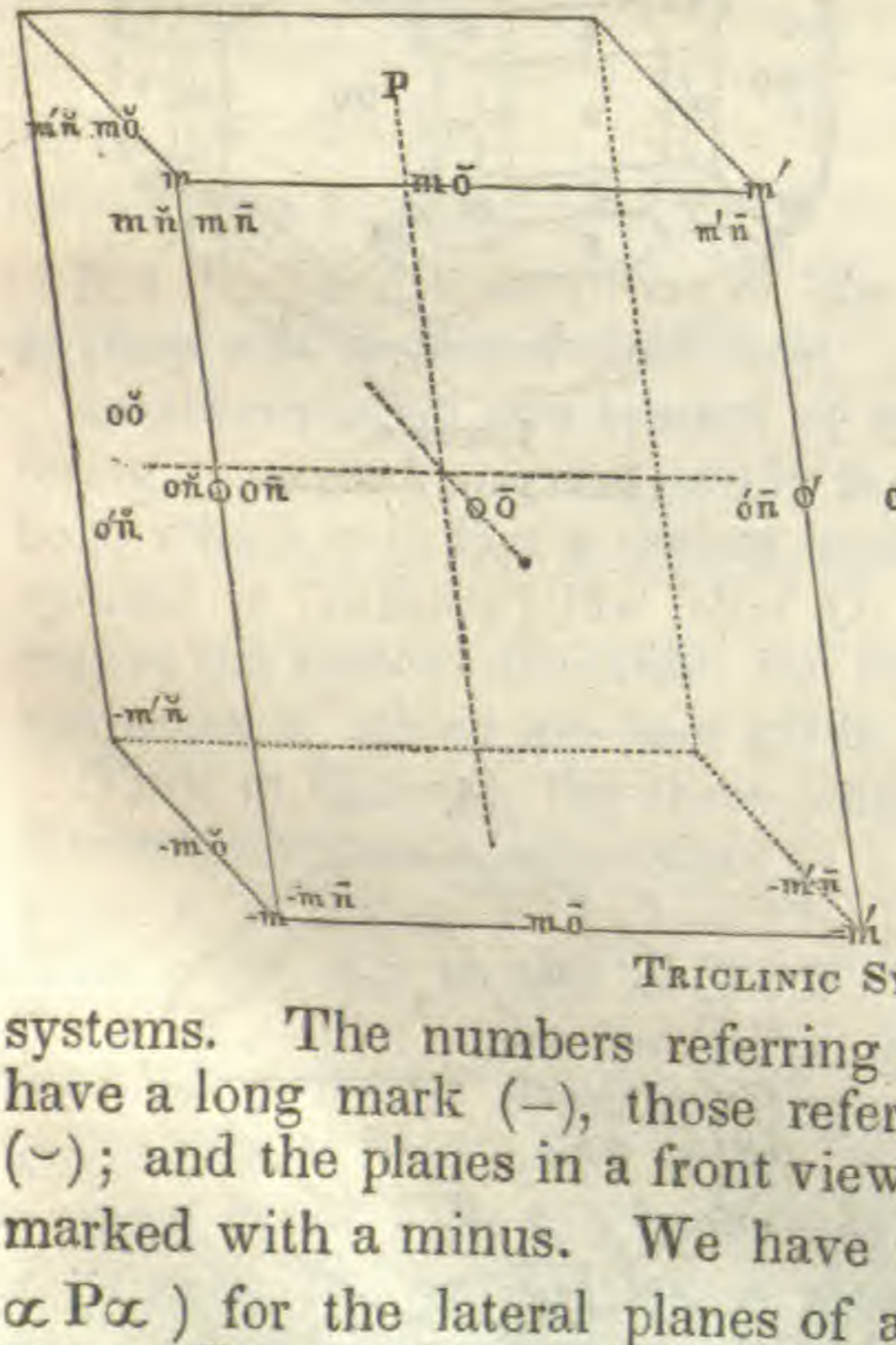
mark (⌣) over them, and those referring to the longer axis, would in like manner have a long mark (–). The series $\frac{1}{2}$-ŏ, 1-ŏ, 2-ŏ, o-ŏ, (corresponding to Naumann's $\frac{1}{2}\breve{P}\infty$, $\breve{P}\infty$, $2\breve{P}\infty$, $\infty\breve{P}\infty$, or $\frac{1}{2}:1:\infty$, $1:1:\infty$, $2:1:\infty$, $\infty:1:\infty$), consists of planes *parallel* to the shorter lateral axis, (which axis is therefore infinite for these planes), and which vary in the length of the vertical axis (a), from $\frac{1}{2}a$, to $1a$, $2a$, ∞a or infinity. The planes $1\text{-}\breve{2}$, $2\text{-}\breve{2}$ as the figures show, belong to one and the same vertical zone, the ratio of the lateral axis being the same ($2:1$), while the length of the vertical is $1a$, for the first, and $2a$ for the second.

In the oblique *monoclinic* system, figure 4, the sign for minus ($-$) is used, as done by Naumann, $\frac{1}{2}$-o, 1-o, o-o, $-\frac{1}{2}$-o, being in one series, the last below the horizontal axes (corresponding to $\frac{1}{2}P\infty$, $P\infty$, $\infty P\infty$, $-\frac{1}{2}P\infty$ of Naumann). Another vertical series is $\frac{1}{2}$, 1, o, -1 (equivalent to $\frac{1}{2}P$, P, ∞P, $-P$).

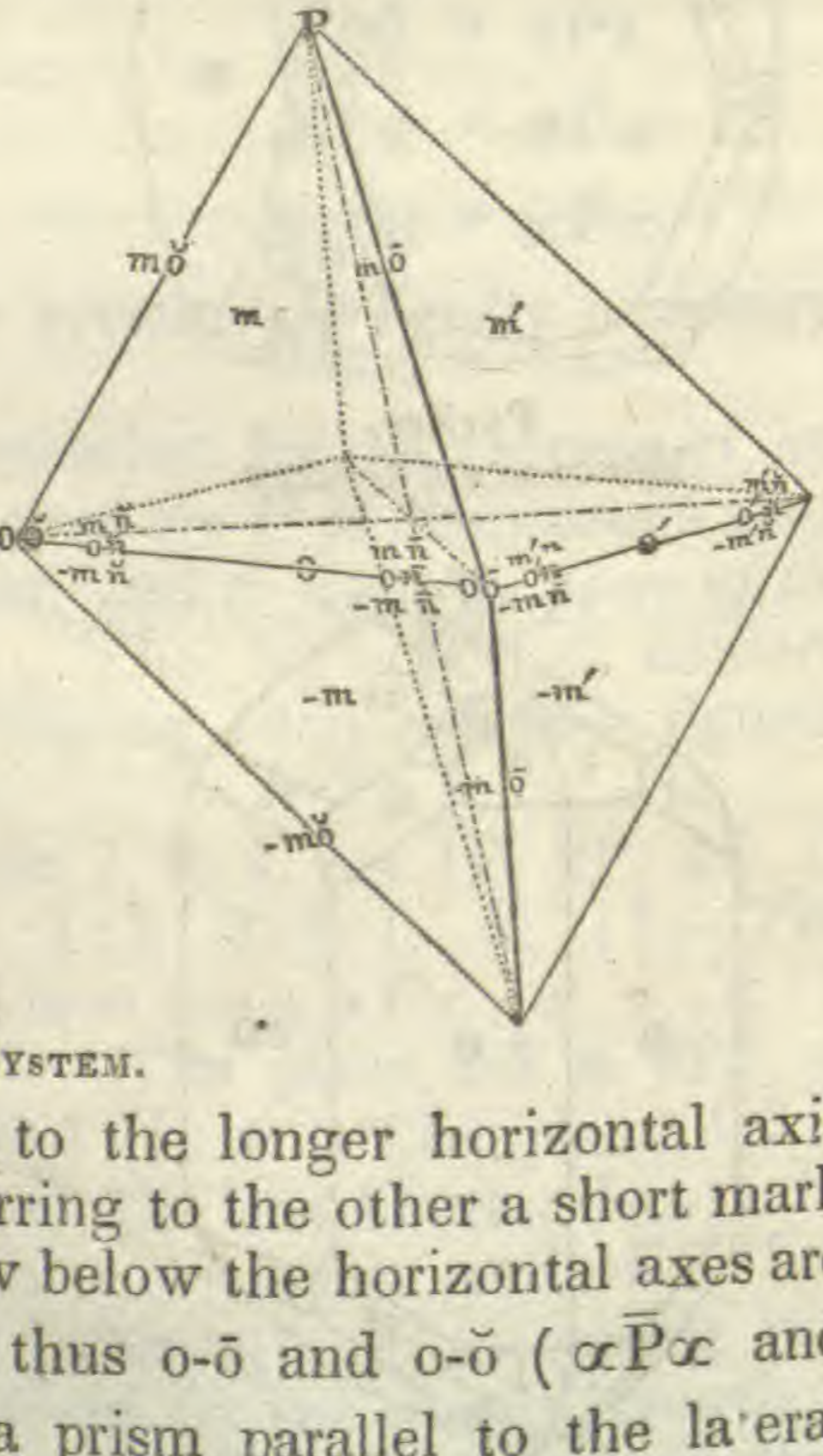
In this system, the lateral axes are unequal, one being at right angles to the vertical, and the other inclined. The numbers referring to the latter are distinguished by an accent, as in the vertical series 1-o′, 2-o′, o-o′, (equivalent to $P'\infty$, $2P'\infty$, $\infty P'\infty$). Those referring to the other lateral axis have no mark.

In the *triclinic* system, I vary a little from Naumann, approximating more in plan to that for the monometric and trimetric

5.



6.



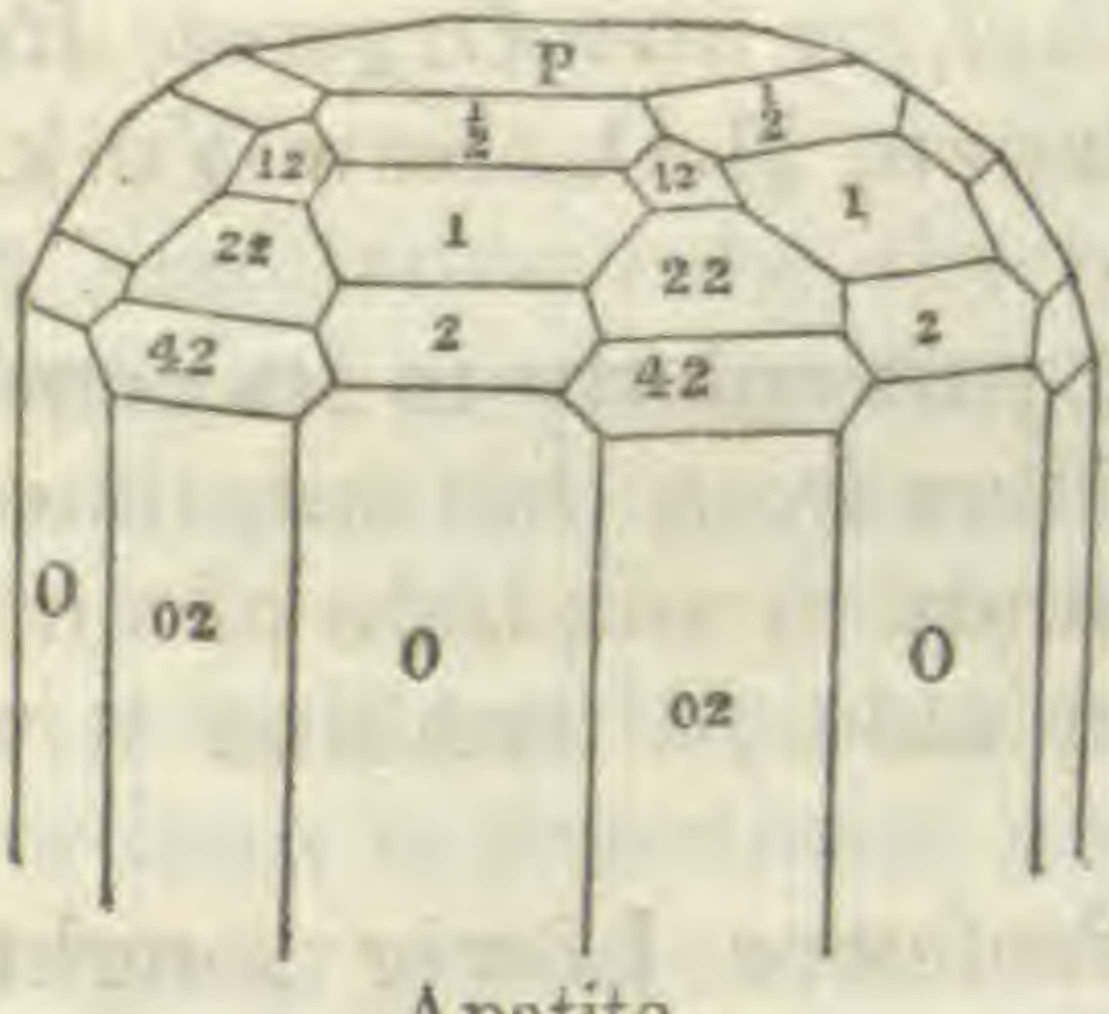
Triclinic System.

systems. The numbers referring to the longer horizontal axis have a long mark (–), those referring to the other a short mark (˘); and the planes in a front view below the horizontal axes are marked with a minus. We have thus o-ō and o-ŏ ($\infty\bar{P}\infty$ and $\infty\breve{P}\infty$) for the lateral planes of a prism parallel to the lateral axes. But as the axes are not only unequal, but cross at an oblique angle, and consequently have one obtuse angle and one acute, another mark is necessary; and for the purpose of distinction, the planes pertaining to the acute angle in figure 5, have an accent, and those to the obtuse angle, none, (or the reverse, if the fundamental form be oblique from an acute edge). The following vertical series of planes will be observed in figure 6, an octahedron formed on the angles of the prism represented in figure 5. The positions of the planes are indicated by the place of the symbols, the planes themselves not being represented. The letters m, n, here used, stand for any numerals that may occur.

$m\text{-}\breve{o}$	$m\text{-}\breve{n}$	m	$m\text{-}\bar{n}$	$m\text{-}\bar{o}$	$m'\text{-}n$	m'	$m'\text{-}\breve{n}$
$o\text{-}\breve{o}$	$o\text{-}\breve{n}$	o	$o\text{-}\bar{n}$	$o\text{-}\bar{o}$	$o'\text{-}n$	o'	$o'\text{-}\breve{n}$
$-m\text{-}\breve{o}$	$-m\text{-}\breve{n}$	$-m$	$-m\text{-}\bar{n}$	$-m\text{-}\bar{o}$	$-m'\text{-}n$	$-m'$	$-m'\text{-}\breve{n}$

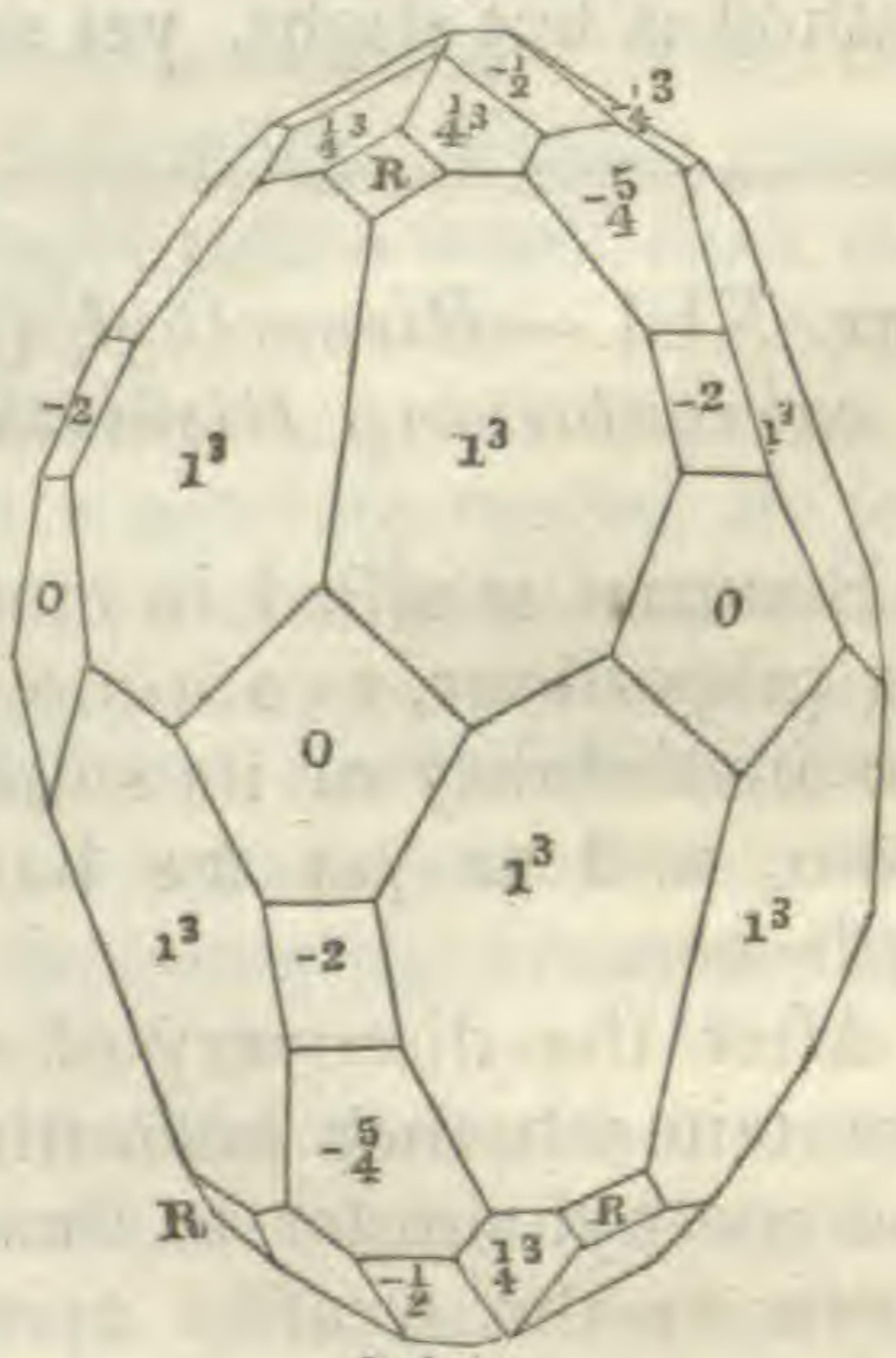
The lettering for the hexagonal system (figs. 7, 8) is a simple transfer of the ratios as used by Naumann, in the manner already explained, and farther elucidation is hardly required. In figure 7,

7.



Apatite.
HEXAGONAL SYSTEM.

8.



Calcite.
HEXAGONAL SYSTEM.

the numbers ½, 1, 2, o in one vertical series, exhibit the relative lengths of the vertical axis of the planes, viz. $\frac{1}{2}a$, $1a$, $2a$, ∞a. In the series 1-2, 2-2, 4-2, o-2, the same fact is shown, the relation of the vertical axis for these planes being $1a$, $2a$, $4a$, ∞a. In figure 8, R is synonymous with 1.

In the *monometric* system, (fig. 1,) the method is the same, except that since the vertical axis equals the lateral, no distinction is made, and the first of the two figures in a symbol does not necessarily refer to the vertical axis. The expressions are the general expressions, as used by Naumann.

In conclusion, it may be observed, that the letter P, employed by Naumann, is hardly necessary even for the *written* symbol, and the expressions would be even more intelligible in description, without the use of it; for the short or long mark, referring to the shorter or longer lateral axis, and the accents, are here annexed to the figures themselves which have reference to these axes, and not to a letter P, of no special significance. Of the descriptive expressions for figure 2, the first of the two following methods—

Author's,	0,	1,	2,	4,	∞,	$1\text{-}\infty$,	$\infty\text{-}\infty$,	$\infty\text{-}2$,	$\infty\text{-}3$,	2-2,	3-3,	4-4,	$\frac{3}{2}\text{-}3$,	4-2
Naumann's	0P,	1P,	2P	4P,	∞P,	$P\infty$,	$\infty P\infty$,	$\infty P2$,	$\infty P3$,	2P2,	3P3,	4P4,	$\frac{3}{2}P3$,	4P2

is certainly as full and explicit as the second or Naumann's. Compare also the descriptions of figure 3.

Author's,	∞,	$\frac{1}{2}\text{-}\breve{\infty}$,	$1\text{-}\breve{\infty}$,	$2\text{-}\breve{\infty}$,	$\infty\text{-}\breve{\infty}$,	1,	$1\text{-}\breve{2}$,	$2\text{-}\breve{2}$
Naumann's,	∞P,	$\frac{1}{2}\breve{P}\infty$,	$\breve{P}\infty$,	$2\breve{P}\infty$,	$\infty\breve{P}\infty$,	P,	$\breve{P}2$,	$2\breve{P}2$

In the first of these, the short mark (˘), as explained, is placed where it properly belongs over the figure which directly refers to the shorter lateral axis. This modification of Naumann's method is but slight, yet seems to be of some importance.

ART. XLI.—*Bismæthyl, (Bismuth-ethyl,) a new Organic Radical containing Bismuth;* by D. BREED, M.D., New York.

BISMUTH is allied in many respects, particularly in its combining proportions, to antimony, but it differs from that substance in the insolubility of its sulphur compounds in sulphide of ammonium, and as yet we have not been able to combine it with hydrogen.

After the discovery of stibethyl, Professor Löwig sought to ascertain whether bismuth may not form compounds with ethyl and methyl similar to those of antimony, and in facts as already given in the treatise upon stibethyl, bismæthyl was produced quite agreeing in its external properties with stibathyl.

During my residence in Zürich in the summer of 1851, under the instruction of Professor Löwig, I submitted bismæthyl to a particular investigation; but I regret my stay was not long enough to bring the research to a termination. In the following pages I give the results thus far obtained, and hope in a second article to complete the details of the investigation.

The substances for producing bismæthyl are iodid of ethyl and bismuth-potassium. The latter is produced similarly to antimonium-potassium, but as bismuth fuses easier than antimony, we must, in the preparation of bismuth-potassium be careful that the process progresses as fast as possible. Bismuth-potassium is best obtained when we bring 16 ounces finely pulverized bismuth and 20 ounces crude tartrate of potassa (also pulverized) into a Hessian crucible, which is then covered and at first slowly heated, then the fire is increased to such a degree that the crucible attains to white heat in half an hour, at the longest. In this state the furnace, yet full of glowing coals, is closed air tight, and left to cool slowly. The bismuth-potassium is found at the bottom of the crucible as a silver-white leafy crystalline mass. It is easily fusible and often remains fluid or soft after cooling. Brought in contact with water it evolves hydrogen gas. It tastes strongly alkaline. Exposed to the air it soon decomposes, but in thick pieces it can be kept long in a closely stopped bottle. The alloy is brittle and easily pulverized.

The iodid of ethyl is produced in the ordinary way by the united action of iodine and phosphorus upon alcohol of 90 per cent.

Bismæthyl differs from stibethyl essentially in the fact that it cannot be distilled alone but at a certain temperature decomposes with a powerful explosion. From this it is evident that it cannot be formed by heating iodid of ethyl with bismuth-potassium, as stibethyl is formed with antimonium-potassium. The best method of making bismæthyl is the following: Finely pulverized bismuth-potassium is quickly brought into a small flask into which an excess of iodid of ethyl is speedily poured; the apparatus is immediately closed with a cork through which passes a long distillation-tube discharging into a receiver cooled by ice. After a few moments the action of the iodid of ethyl upon the bismuth-potassium commences, accompanied by considerable evolution of heat, in consequence of which the excess of iodide of ethyl which has been added distils off. Cautious exposure to the water-bath is sometimes employed to facilitate the complete distillation, or to hasten the commencement of the action. We now pour distilled and well boiled water into the flask, close it airtight and then leave it upon the water-bath, until the mass softens and the iodide of potassium is dissolved. We now repeat the described operations with ten or twelve flasks and then bring their softened contents as quickly as possible into a large flask filled with carbonic acid and repeatedly shake the whole with a considerable quantity of ether, which must not be sparingly used since bismæthyl is only slightly soluble in ether. To the etheric solution we add water freed from air and completely distill off the ether over the water-bath. After this operation is terminated, we find the bismæthyl below the water upon the bottom of the flask. To obtain it completely pure it is distilled with water over a spirit lamp, then shaken with a small portion of dilute nitric acid to remove a little oxyd which forms, and finally dried over chlorid of calcium. It is evident that in all these operations the air must be excluded. I employed the apparatus of Professors Löwig and Sweizer described in the treatise upon stibethyl.

The analysis of bismæthyl offers on the whole no difficulty. The combustion is easy and complete with oxyd of copper itself without the employment of chlorate of potassa. The determination of bismuth is also easy, because it may be completely oxydized by nitric acid. It is best accomplished in the following manner. Into a capacious flask we bring a little water, and into this the glass bulbs filled with weighed bismaethyl. The flask is closed with a cork through which passes a cup-tube drawn to a point below and dipping into the water of the flask. Through this cup-tube fuming nitric acid is added. When all is arranged, the small bulbs filled with bismæthyl are broken by shaking, and afterwards the bismæthyl is decomposed by nitric acid. After the oxydation the whole apparatus without separation is left sometime standing, then the nitric acid solution is poured into a weighed platinum bowl, and the wash water of the flask and cup-tube added. We now evaporate to dryness upon the water-bath, and cautiously decompose the nitrate of bismuth over a spirit lamp, and weigh the thus obtained oxyd of bismuth. Below are the results of a few analyses.

Carbon,	24·81	24·38	24·27
Hydrogen,	5·24	5·27	5·26
Bismuth,	69·95	70·47	70·47
	100·00	100·12	100·00

If we assume for the atomic weight of bismuth 208 as given by the latest researches, the accompanying analyses best agree with the following atomic proportions.

12 at. carbon,	72	24·44
15 " hydrogen,	15	5·08
1 " bismuth,	208	70·48
	295	100·00

The formula for bismæthyl therefore completely corresponds to that of stibethyl; Bi Ae_3.

Bismæthyl appears as a water clear, or pale yellow, thin-flowing fluid, of 1·82 s. g. It possesses an extremely disagreeable odor, resembling stibethyl, and produces even when only a trace is inhaled, a highly disgusting, burning sensation upon the tip of the tongue. In the air it throws out thick fumes, inflames with a slight explosion, diffusing a deep yellow smoke of oxyd of bismuth. This appearance is most brilliant if we expose to the air some filter paper covered with bismæthyl. By fuming nitric acid it is decomposed with vivid appearance of fire and violent explosion. In the same manner it burns in chlorine gas whilst carbon is deposited. In contact with bromine it burns and shows throughout the same appearances as stibethyl. It is quite insoluble in water, not easily soluble in ether but easily so in anhydrous alcohol. If bismæthyl be heated by itself in a retort, it commences to boil even below 50°, evolving a gas which burns with a clear flame and contains no bismuth, but metallic bismuth is deposited in the retort. If we raise the heat to 160° then the whole apparatus is instantaneously shattered by a violent explosion.

In chemical relations bismæthyl behaves quite like an organic radical. If to its alcoholic solution we add a solution of iodine or bromine, the color vanishes under considerable evolution of heat and production of iodid or bromid of bismæthyl. The compounds however are less permanent than the corresponding ones of stibethyl. If for example we leave standing for a short time an alcoholic solution of iodide of bismæthyl, iodide of bismuth is deposited. Bismæthyl easily dissolves in dilute nitric acid, and of course the solution contains nitrate of bismæthyl, if however we evaporate the nitric acid solution pure nitrate of bismuth remains.

The description of the compounds of bismæthyl must be reserved for a second paper.

Art. XLII.—*Notice of a work entitled Petrifactions and their Teachings, or a Hand-Book to the Gallery of Organic Remains of the British Museum*, by Gideon Algernon Mantell, Esq., LL.D., F.R.S.*

This work of Dr. Mantell is an excellent companion for the student as well as amateur visitor of the gallery of organic remains in the British Museum. Without pretending to enumerate the species, the duty of a proper catalogue, it gives a general sketch of the collections of fossils in their different apartments, and passes in detailed review the more remarkable specimens, illustrating them often with excellent cuts, and extended observations. A lucid introduction and synopsis of the contents of the rooms with a table of the fossiliferous deposits of Great Britain, prepare the way for the more particular enumerations. We mention some of the prominent objects of interest.

Among the minerals, the most interesting are the native or meteoric irons and meteoric stones of which there are numerous specimens and from many countries.

The collections of fossil plants, or vegetable productions, are very complete. The Algæ and Fucoides—the Equisetaceæ—Calamites and Ferns—the Sigillariæ and Stigmariæ—the Lepidodendra—Coniferæ and palms and their cones and fruits—Cycadeæ and Zamieæ of ancient eras, present to us a striking picture of the early vegetation of the globe. The fossilized trees of

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* 496 pp. large 12mo., with numerous illustrations, forming a volume of Bohn's Scientific Library.

Australia and Van Diemens Land and of the island of Portland, are also conspicuous in the museum. Many of the fossil vegetables are illustrated in Dr. Mantell's work by fine drawings.

The impressions of feet in stone are next described, especially the Chirotheria, now attributed to an enormous frog or Batrachian, though Dr. Mantell does not regard this conclusion as being fully sustained by the osseous remains hitherto discovered.

The *ornithichnites* (footsteps of birds) are well represented in the British Museum by specimens transmitted by Dr. Deane and President Hitchcock, and the interesting conclusion that birds, and among them those of gigantic size, existed so early as the era of the new red sandstone appears to be plainly shown, although still awaiting the discovery in the same strata of bones indubitably ornithic.

There is a large room containing interesting specimens to be differently arranged hereafter. Among them are bones of large animals from the drift of England, the elephant, horse, deer, ox: also the Megalonyx of North America and the Mylodon of South America, the Moa, the gigantic bird of New Zealand, (with calcined bones of men and dogs, probably the relics of the cannibal feasts of the natives in early times.) The history of the Moa, first made known in Europe by the missionaries, has been successfully explored by Mr. Walter Mantell, and the museum is enriched by many specimens derived from his exertions which have afforded the means of reconstructing the skeleton.

These birds probably abounded in New Zealand in later geological ages, and there were no ferocious devourers to keep them in check. The dimensions of the largest of the Moa family justify the conclusions that have been entertained regarding the size of the still earlier birds of the valley of the Connecticut. Two species of Apteryx, supposed cotemporaries of the Moa, still survive in New Zealand, and the Notornis, another cotemporary, a very beautiful bird, has come down to our time, the last survivor having been but recently killed.

The department of the Radiata, including the Stelleridæ—star fishes,—and the Crinoidea—Encrinites, Pentacrinites, &c., is richly represented in the British Museum.

The remains of the Saurian or Lacertine family are immense and astounding. Here is the vast collection formed by Dr. Mantell and that also by Mr. Hawkins of Gloucester, in addition to many more specimens from various places. The colossal forms of the Iguanodon, of the Pelorosaurus, of the Hylæosaurus, of the Megalosaurus, of the Ichthyosaurus and Plesiosaurus, of the Mosasaurus and Pterodactyles, and of many more of the families of extinct reptiles of goneby ages are exhibited in wonderful profusion and grandeur.

As we walked through these rooms in company with Dr. Mantell, the great expounder of these preadamites, we felt as if we were almost identified with the hoary antiquity of which these wonderful remains are the indubitable witnesses. In the continental museums we saw many fine remains of this large family, but in no place so vast a collection as in the British Museum. Truly the fossil Saurian age is fully recorded between the chalk and the coal; and the analogous forms now existing on earth—the crocodiles, the alligators, gavials, caymans, Iguanas, &c., not to mention the marine Saurians of the Gallipagos islands and numerous other Lacertine animals, furnish sufficient evidence that these creatures, although hideous and revolting, have entered largely into the plan of creation. We must refrain from citing particulars from Dr. Mantell's account of this fossil family, which occupies three-fifths of his work, (300 pages out of 500,) and which furnishes a lucid and interesting description of their osteology, functions and rank in the scale of being, besides descriptions of the strata in which they occur, and other geological facts bearing upon their history.

The work continues with accounts of the fossil Carnivora of the Caverns, the Marsupials of Stonesfield, fossil shells and corals, fossil fishes, and mammalian remains.

This hand-book is properly a scientific treatise upon the more remarkable fossil animals of the museum, abounding in valuable remarks of general interest, as well as scientific descriptions, and it may well stand as a third volume to the distinguished author's "Wonders of Geology." B. S., Sr.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *Optical Properties of Isomorphous Substances.*—Senarmont has communicated the results of an investigation and comparison of the optical properties of isomorphous crystals. This investigation has led to the establishment of three orders of facts which the author expresses as follows: 1st. A great number of substances geometrically and chemically isomorphous, present optical properties which are identical. Of this identity, the arsenates and phosphates of potash and ammonia, the sulphates of baryta, strontia and lead, those of zinc and magnesia, and the double sulphates of ammonia and potash with the magnesian oxyds, present examples. 2nd. Certain substances—as for instance the dextro-tartrates and levo-tartrates of Pasteur—which possess neither a chemical nor a geometrical isomorphism, exhibit an absolute identity in doubly refracting properties. 3d. In another class of substances geometrically and chemically isomorphous, the optical properties are com-

pletely opposed to each other. Thus in the hyposulphates of lime, lead, and strontia, the single axis of double refraction is sometimes the direction of the greatest and sometimes that of the least elasticity. In chromate and sulphate of potash, the axes of least and greatest elasticity have made a reciprocal exchange of direction, while the axis of mean elasticity is the same in both. In arragonite and carbonate of lead the same exchange occurs between the axes of least and of mean elasticity. These properties have enabled the author to produce united crystals which exhibited very remarkable optical phenomena. Thus the hyposulphate of strontia united in progressively increasing proportions with hyposulphate of lead, gives a series of salts in which the double refraction at first becomes enfeebled and then reappears with a contrary sign, so that we find toward the middle of the series, mixtures which behave like hyposulphate of lead for one extremity of the spectrum and like hyposulphate of strontia for the other, while for the intermediate part there is no double refraction. Very remarkable phenomena are observed in mixtures of the tartrate of soda and potash with tartrate of soda and ammonia, in which two salts the optic axes are in planes at right angles to each other. The angle of the optic axes of the potash salt, originally 76°, begins by diminishing, at the same time that the red axes (axes for the red rays), at first more dispersed than the violet ones, approach each other; they finish by uniting. At this instant the dispersion of the optic axes vanishes and with it the singular anomalies of form and color observed by Herschel in the monochromatic curves. The violet and red axes again separate, but the red always moving more rapidly than the others are then less separated. The dispersion is now the inverse of what it was originally, and the rings are red within and blue without. Finally, an instant arrives at which the red axes reunite; the crystal has then only a single axis for the red rays, but two for the violet, and these last are still separated by at least 12° in their plane of primitive divergence. After this the red axes in their turn separate in a diagonal plane at right angles to the last, while the violet axes continue to approach. The mixed crystal behaves then like the ammonia salt with reference to the red, and like the potash salt with reference to the violet axes, while it has but a single axis for the intermediate colors. Finally, as the influence of the ammonia salt increases the violet axes pass like the red into a plane at right angles to their original plane, and end by making in this plane an angle of about 46° to 48°, while the red axes make an angle of 60°. The optical character is then that of the ammonia salt. The author draws a parallel between the phenomena exhibited in the case of the mixed tartrates, and those of certain mineral species, as for instance the topazes and the micas, and shows how completely the optical properties observed confirm our received ideas of mineral species as mixtures of isomorphous chemical species. The author directs attention to the fact that physical investigation is in advance of chemical analysis as respects topaz, and that an accurate study of the micas will probably lead to the discovery of species in which the planes of the optic axes correspond with two diametral planes at right angles to each other. In a subsequent communication the author gives the result of an examination of forty-five species of mica by which he obtained a complete confirmation of his prediction in reference to this mineral. In this examination he assumes the crystalline form of mica to be always a right rhombic prism, and never an oblique one as is often supposed, basing his conclusion both upon optical character, and upon the forms of twin and hemihedral crystals. The number of micas in which the plane of the optic axes contains the lesser, is about equal the number of those in which it contains the greater, diagonal of the rhombic base. The researches of Senarmont will possess much interest for mineralogists, especially since the laborious and extended investigations of the micas which have been made in this country by Silliman and by Blake—*Comptes Rendus*, xxxiii, 447, 684, and *Ann. de Chimie et de Physique*, xxxiii, 391.

2. *On the double refraction produced by compression in Crystals belonging to the regular system.*—Wertheim has compared the phenomena of double refraction as produced in crystals belonging to the regular system by means of pressure, with those which similarly applied pressures produce in homogeneous uncrystallized media. The results obtained in the case of the last mentioned substances and communicated in a former paper were as follows. The compression acting perpendicularly to the two opposite faces of a parallelopiped, the neutral axes are parallel and perpendicular to the direction of the force. 1st. In all other directions the parallelopiped exerts a doubly refracting action, and the colors of the two images are most vivid when the plane of primitive polarization and the principal section of the analyzing prism make an angle of 45° with the direction of the force. 2d. The difference of path of the ordinary and extraordinary rays is proportional to the force applied, independent of the length and thickness, and reciprocally proportional to the breadth of the mass. 3d. For many species of glass the changes which produce the same difference of path are proportional to the coëfficients of elasticity.

In the case of crystals belonging to the regular system, Wertheim considers that he has established, 1st. That crystals of the regular system cannot be considered as bodies optically homogeneous or isotropic. 2d. That the axes of elasticity of the ether do not always coincide with the mechanical axes of elasticity, and that the pressures or tensions in the ether are not always proportional to the molecular pressures or tensions. 3d. That, reciprocally, optical properties alone are insufficient to make known the direction and magnitude of the mechanical pressures existing in the interior of crystals naturally doubly refracting.—*Comptes Rendus*, xxxiii, 567.

3. *Researches on Crystallization in the dry way.*—Ebelman has presented to the Academy of Sciences a continuation of his most interesting researches on the artificial production of minerals. By employing as solvents alkalies in place of acids, as in his former investigations, together with a certain proportion of silica to diminish the too great volatility of the alkali, the author has obtained peridot, perovskite or titanate of lime, rutile and glucina. The crystals of rutile produced were transparent and of a fine red color. Their density was 4·26; their form identical with that of the native mineral. Glucina was obtained in well defined crystals, large enough to admit of measurement. These crystals were six-sided prisms terminated by a six-

sided pyramid placed on the edges of the base, the angle between a face of the prism and one of the pyramid is 151° 22′. From this it follows that glucina is isomorphous with alumina, and its constitution is therefore represented by the formula Gl_2O_3, as Berzelius maintained. The crystals of glucina have a hardness comparable with that of corundum; they are not attacked by acids except by concentrated and boiling sulphuric acid; bisulphate of potash, however, easily attacks them. The density of crystallized glucina is 3·058, its atomic volume is 155; that of alumina is 160. In a second part of his memoir Ebelman points out a second method of obtaining crystals in the dry way, namely, by precipitation. By causing lime in large fragments to act upon borate of magnesia, the magnesia is precipitated under the form of transparent crystals, sometimes large enough to be seen by the naked eye, and which are usually combinations of the cube and regular octahedron. Their density is 3·636, and their hardness is almost equal to that of feldspar; they consist of pure magnesia. The periclase of Scacchi is magnesia containing 6 or 8 per cent. of protoxyd of iron. By a similar process the protoxyds of nickel, cobalt, and manganese may be obtained crystallized. The protoxyd of nickel is presented under the form of cubo-octahedra, of a green color, and almost unattacked by acids. Their density is 6·80, and the atomic volume of oxyd of nickel is identical with that of magnesia. Silicates of iron are completely decomposed by lime; dilute acids dissolve silicate of lime and leave a crystalline sand of Fe_2O_3, FeO. When lime is made to act upon a vitreous silicate of oxyd of titanium and alkali, the action of acids isolates a crystalline sand with the form, density and composition of perovoskite, CaO, TiO_2. In a similar manner crystalline compounds of tantalate of iron and tantalate of lime analogous to the tantalites and pyrochlore, were obtained. In conclusion, the author points out the great importance of these facts in a geological point of view, more especially in respect to the relations of contact existing between sedimentary rocks and the igneous rocks which traverse them.—*Comptes Rendus*, xxxiii, 525.

4. *New mode of preparing Nitrogen and Chlorine.*—MAUMENÉ has observed that a mixture of two equivalents of nitrate and one equivalent of chlorid of ammonium when fused together, yield nitrogen, chlorine, and the vapor of water. The reaction is expressed by the equation $2NO_5, NH_4O+NH_4Cl=5N+Cl+12HO$. The reaction is violent and might be dangerously so, but it may easily be rendered perfectly safe and regular by mixing sand with the materials. To obtain 26 litres of dry nitrogen and 5 litres of chlorine, the author heats together 75 grammes of sal-ammoniac, 25 grammes of nitrate of ammonia, and 400 grammes of sand, all well dried.—*Comptes Rendus*, xxxiii, 401.

5. *Researches on Populine.*—PIRIA has communicated the results of an investigation of populine which possess great interest. The constitution of populine was found to be represented by the formula $C_{40}H_{22}O_{16}+4HO$; at 100° C. it loses the 4 aq. and becomes anhydrous. One equivalent of populine + 2 eq. of water contain the elements of one eq. of salicin and one eq. of benzoic acid, as represented by the equation $C_{40}H_{22}O_{16}+2HO=C_{26}H_{18}O_{14}+C_{14}H_6O_4$.

When populine is boiled for a few minutes with baryta water a colorless liquid is obtained, which, after the separation of the excess of baryto by means of a current of carbonic acid, contains nothing but salicine and benzoate of baryta. With bichromate of potash and sulphuric acid populine yields hydruret of salicyl in abundance: by boiling with strong nitric acid it is transformed into nitro-benzoic, trinitrophenic, and oxalic acids; finally under the influence of acids it is resolved into benzoic acid, saliretine and grape sugar. When populine is dissolved in ten or twelve times its weight of pure nitric acid of 1·30, a new substance is produced which the author calls benzo-helicine and which bears the same relation to helicine which populine bears to salicine. Benzo-helicine is transformed into helicine and benzoic acid when boiled with caustic magnesia.—*Comptes Rendus*, xxxiv, 138.

6. *Chemistry of Perfumery.*—HOFMANN has communicated in a letter to Liebig some interesting facts in reference to the substances now used extensively in flavoring syrups, sugar drops, &c. Essence of pine apple is a solution of butyric ether in alcohol; essence of jargonelle pear a solution of acetate of amyl; essence of apples a solution of valerianate of amyl. Oil of cognac and oil of grape are also amyl compounds; artificial oil of bitter almonds (essence of mirbane) a more or less pure nitro-benzol.—*Ann. der Chemie und Pharmacie*, lxxxi, 87, *Jan.*, 1852. W. G

7. *Note respecting the Dimensions and Refracting Power of the Eye;* by Prof. J. D. FORBES, (Proc. Roy. Soc. Edinb., Dec. 3, 1849, p. 251.)—Whilst lecturing lately on the subject of Vision, I consulted some recent authorities on the dimensions and curvatures of the refracting apparatus of the eye; and having calculated from them the convergence of rays within the eye, it may save trouble to others to put them on record.

The measures of the eye given in almost every English work on the subject, are those given by Young on his own authority, or that of Petit. In the fifth volume of Dove's Repertorium, I find a series of measures collected by Treviranus from his own and preceding observations, which I have converted below from French lines into decimals of an English inch. In these the curvatures are supposed spherical. In the same work of Dove, I find a series of measures by Dr. Krause of Hanover, on eight recent human eyes, which seem to have been made with uncommon care, and in which the deviation of the surfaces from sphericity is noticed. I have preferred these last for the purpose of calculation, because *all* the measures are taken from the same eye, which is not the case with the numbers collected by Treviranus. I have consulted the original paper of Krause in Poggendorff's Annalen, vols. xxxi and xxxix, where it appears, (1.) That the cornea is thicker at the sides than in the centre; (2.) The anterior curve of the cornea is nearly spherical, the posterior parabolic; (3.) The anterior surface of the lens is elliptical, the lesser diameter being in the axis of vision, the posterior surface is parabolic; (4.) The figure of the retina, or the posterior surface of the vitreous humor, is an ellipsoid.

The following are those given by two eminent German authorities, Treviranus and Krause, when reduced to English inches:—

	Mean of several authors by Treviranus.	Mean of eight measures by Krause.
	Inches.	Inches.
Thickness of cornea (central part,)	0·032	0·040
Distance of first surface of lens from back surface of cornea,	0·104	0·107
Pupil behind cornea,	0·096	0·083
Thickness of lens,	0·181	0·181
Axis of vitreous humor,	0·548	0·567
Axis of the eye from the interior of the cornea to the retina,	0·833	0·855
Radius of first surface of cornea,	0·301	0·348
Radius of first surface of lens,	0·280	0·369
" of second do.,	0·196	0·201
Curvature of retina near the axis,	0·534	0·523

These numbers agree tolerably well, only that the radius of curvature of the first surface of the lens is disproportionately great in the last column. This arises from the circumstance, that it is derived by calculation, for the curvature of an ellipse at the lesser axis, the two axes of which are alone given by Krause. Now, it is evident, that if we regard the lens *as a whole*, or even any considerable breadth of it, its mean radius of curvature will be sensibly smaller. In fact, Krause finds that it may be tolerably represented by a circular curvature, having a radius of ·329 inches. It occurred to me, however, that by taking the *greatest* density of the lens, as given by Brewster, and the curvature of the middle part, both anterior and posterior, as given by Krause, I ought to arrive at a close approximation to the course of the axial pencil.

I have adopted for the refractive indices of the parts of the eye, those given by Sir D. Brewster in his original paper in the Edinburgh Philosophical Journal, vol. i, page 44, with the exception of that of the densest part of the lens, which is almost certainly misprinted. They are as follow:—

Aqueous humor,	1·3366 $=\mu_1$
Crystalline, outer coats,	1·3767
" middle coats,	1·3786
" central coats,	1·3990* $=\mu_2$
" the whole,	1·3839
Vitreous humor,	1·3394 $=\mu_3$

Calculating from the preceding data, with Sir D. Brewster's indices of refraction, the author finds the positions of the foci, towards which the rays converge, after refraction at the successive surfaces, to be the following (reckoning from the *interior* surface of the cornea, the thickness of which has been neglected)—

	For rays falling parallel on the cornea.	For rays diverging from a point 10 inches distant.
	Inches.	Inches.
After first refraction at the aqueous humor,	= 1·382	1·541
After second refraction at first surface of the lens,	= 1·260	1·377
After third refraction into the vitreous humor,	= 1·060	1·135

* In the Edinburgh Phil. Journ., we find 1·3999. But I take this to be a misprint, as in Sir D. Brewster's own subsequent writings, we always find 1·3990.

Now the measure of the axis of the eye we have seen to be only ·833 inch, according to Treviranus, and ·855 according to Krause; consequently, rays of mean refrangibility (to which Brewster's measures refer) converge to a point no less than ·227 inch behind the retina, when the rays fall parallel on the cornea, and ·302 when the object viewed is at 10 inches distance. The axis of the eye, as even measured by Dr. Young, though somewhat greater than we have reckoned it above, (Dr. Young makes it ·91,) does not come up to the requisite dimensions; and Dr. Young, with his usual acuteness, ascribes the difference to the gradually varying density of the strata or coats of the lens,* the dense small nucleus evidently acting as a lens of comparatively short focus; and this explanation is probably the correct one, to which we may add, that the configuration of the coats of equal density, which, near the surface of the lens, are very elliptical, become, near its centre, gradually nearly spherical. On this account, it is all but impossible to predict the exact course of the rays through a structure of so much complication.

Dr. Young had considered the case with his usual attention and penetration. He investigates the focus of a spherical lens, or lens with surfaces which are segments of spheres, and whose density is variable, and the result may be recalled here as one which, perhaps, has not been sufficiently remarked. "On the whole," he says, "it is probable that the refractive power of the human crystalline in its living state is to that of water nearly as 18 to 17 [gives index refr. $=1{\cdot}415$]; that the water imbibed after death from the humor of the capsule reduces it to the ratio of 21 to 20 [1·403], but that, on account of the unequable density of the lens, its effect on the eye is equivalent to a refraction of 14 to 13 [1·439] for its whole size."†

On the whole, these calculations, as well as the considerations into which I entered in a former paper, read to the Society in 1844,‡ on the mechanism of the focal adjustment, have left on my mind the conviction that the optical and mechanical structure of the organ of sight is even less understood than it is commonly believed to be. Simple as are its general arrangements, and comparable, in some respects, to those of artificial combinations, we perceive surfaces figured in a complex manner, and structures of varying refractive density combined in a very complicated manner. Krause's measures of the curvature of the surfaces of the lens confirm the inadmissibility of the all but universal opinion of the variation of density of the crystalline being intended to correct the aberration of spherical surfaces, when, in reality, no such surfaces exist. We are quite unable to trace the exact course by which the rays of light are focalised in the retina, since it depends on the internal constitution of the lens that they do not meet very far behind it; and it still remains at least doubtful how the adjustment to distinct vision of objects at different distances is effected.

Finally, the question of achromatism of the eye has its own difficulties. It is not now contended that the eye has the power of converging equally rays of different refrangibilities; but it is not unreasonable to

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* Nat. Phil., vol. ii, p. 580. † Nat. Phil., vol. ii, p. 82.

‡ Transactions Royal Society of Edinburgh, vol. xvi, p. 1.

suppose that the chromatic aberration is at least partially corrected. One result of the calculations into which I have entered (which were first in part undertaken at my request, by Mr. James Clerk Maxwell, and since entirely repeated and extended by myself), is a clear exhibition of the physical conditions of perfect achromatism in the eye. The form is simpler than I have elsewhere seen, and may at once satisfy any reasonable person of the possibility that the eye might be rendered achromatic, at least for objects at a certain distance; to prove which, so much has been written, and at so great length. The result may be stated in two lines. If we calculate the effect upon the *final* focal distance of the whole refracting system of the eye (q''), of a variation in the refractive index of each of its three humors (denoted by μ_2, μ_3, μ_4). We find this equation when the incident rays are parallel, or reach the eye from a very distant object:—

$$\delta q'' = 1{\cdot}579\,\delta\mu_2 + 1{\cdot}150\,\delta\mu_3 - 2{\cdot}788\,\delta\mu_4.$$

Let the coëfficients $\delta\mu_2$, $\delta\mu_3$, $\delta\mu_4$ denote the dispersion or differences of the indices of refraction for extreme rays, corresponding to the three media, then it is evident, from the negative sign of the third term on the right hand, that they may be so chosen as to annihilate the second side of the equation, or make the variation of focal distances *nothing*, for the differently refrangible rays.

If the rays proceed from a point 10 inches distant from the eye, the equation for the variation of the focus will be

$$\delta q'' = 1{\cdot}873\,\delta\mu_2 + 1{\cdot}402\,\delta\mu_3 - 3{\cdot}298\,\delta\mu_4$$

and the condition which makes this equal to zero, or the focus independent of small variation of the refrangibility of the ray may be satisfied, at the same time that the former equation is satisfied also; consequently, *with three media, as in the eye, we may have perfect achromatism for any two distances;* which would also be sensibly perfect for the intervening ones. Of course by perfect achromatism, we here mean a union of the extreme red and violet rays, the *irrationality* of dispersion does not concern this question.

II. Mineralogy.

1. *Allanite from West Point;* by Dr. C. Bergemann, (from Poggendorff's Annalen, lxxxiv, p. 485, and communicated to this Journal by W. G. Lettsom.)—From Mr. Saemann the mineralogist I received for examination a substance resembling Allanite from the gneiss at West Point, N. Y., which he procured while in the United States. It resembles most the allanite of Jotunfjeld, except that at West Point crystals of considerable size are met with, as well as pure compact masses of the mineral.

Although of late years allanite has been examined more than once, I thought it as well nevertheless to analyse the mineral derived from this new locality. In its mineralogical qualities it agrees with that of Jotunfjeld. Its sp. gr. is 3·4917, which undergoes hardly any change from being heated to redness. The incandescence mentioned by Scheerer and others as manifesting itself on exposing allanite to heat, was not observable in the fragments at my disposal. The substance is all but deprived of its solubility in acids by exposure to a red heat.

In its behavior before the blowpipe, and also with respect to acids, it does not differ from allanites from other sources.

A qualitative examination manifested the presence of substances already known to occur in this mineral; it does not contain glucina or yttria. Peroxyd of iron is present in it to a small amount, but protoxyd of iron exists in it in a larger quantity. These oxyds were separated by the method proposed by Fuchs.

Speaking in a general way, the analysis was conducted in accordance with the method described in detail by Scheerer in his paper upon mineral substances of this nature. The amount of water was derived from the loss of the mineral in weight by exposure to a red heat.

The result of the analysis gave—

$\dddot{Si}$	$\overline{\dddot{Al}}$	$\overline{\dddot{Fe}}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Ce}\,\dot{La}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{H}$	
33·833	13·606	3·330	12 716	0·824	20·902	9·357	1·404	2·950	= 99·023

2. *On the occurrence of Crystalline Zinc Oxyd as a Furnace product in New Jersey*; by Mr. W. P. Blake, (communicated for this Journal.)—I have recently had an opportunity at the New Jersey zinc mines to observe some beautiful crystallizations of zinc oxyd formed not only in the large furnaces used for the manufacture of the amorphous white oxyd, but also in the roasting heap, and under other circumstances which show that the crystals can be produced with great facility.

The blocks of red zinc after being roasted are frequently coated in small patches with delicate acicular transparent crystals of oxyd. The roasting heap is prepared by piling up the ore with a small quantity of wood and anthracite coal, and subsequently igniting it; under these circumstances a portion of the native oxyd must be reduced to zinc vapor, and this is probably the source of the crystals.

I have also noticed small transparent crystals of the oxyd lining cavities in a "matte" or a mass of partly reduced Franklinite which was formed in some experiments for reducing the ore in a furnace.*

Recently large masses and incrustations of crystalline oxyd have been taken from one of the large furnaces which are used to produce the zinc-white. The occurrence of such large and beautiful masses, as in this instance, is by no means frequent; almost all the specimens are slightly colored having an amber yellow and a greenish shade of color, which is probably due to the presence of iron or some other impurities. The masses exhibit all phases of transition from an amorphous white powder to translucency and the clear crystalline condition.

Masses of oxyd occur in various conditions of aggregation, exhibiting a great variety of forms: sometimes in masses of delicate acicular crystals, beautifully arborescent; more frequently in globular mas-

* About a year since Mr. Samuel Wetherill of the zinc works in making some experiments upon the zinc ore, found his crucible filled with long, white, silky crystals. I am indebted to Mr. Richard Jones, the superintendent of the zinc works for a mass of these crystals which he preserved with great care, and I find them to be pure zinc oxyd; some of the crystals are over an inch in length, they are elastic, but very brittle, and much resemble glass threads. The crucible in which they were formed was closed with a luted cover; the ore was mixed with reducing agents and after being highly heated it was allowed to remain in the fire until cold.

ses and coatings with botryoidal surfaces which are drusy or covered with imperfectly formed crystals. Most of the forms observed indicate the formation of the masses by gradual accretion and not as the result of percolation of fused material. But some of the specimens appear to have been so far fused as to flow down through crevices in the furnaces. Some of these are hollow tubes of compact vitreous oxyd two inches in diameter, and four to eight inches in length, the inside being studded with small crystals. These masses were taken from a flue under the retort in which the mixture of ore and coal is heated ; a considerable quantity of fused ore had flowed down into this flue through cracks and fissures, and the oxyd was found investing portions of the surface of this ferruginous slag, which gave it the appearance of having been fused, although it was undoubtedly formed from the zinc vapor issuing from the slag. The tubular masses of oxyd which seemed to have flowed down, may have lined cylindrical cavities in the slag, the specimens having been removed before I saw them ; I am unable to affirm positively upon this point, but that such was the case is indicated by other specimens.

It will be observed that in all the cases of occurrence above cited, zinc vapor was slowly cooling under circumstances which prevented the presence of oxygen in large quantity, indicating that the crystals were formed by the slow oxydation of zinc vapor and not from dissolved or fused oxyd.

The blowpipe reactions with the the purest and cleanest crystals are all those of pure oxyd of zinc. The crystals I have under examination, and I reserve for another occasion an account of their forms and angles.

Works of New Jersey Zinc Co., Newark, March, 1852.

3. *On Carrollite, a new Cobalt Mineral ;* by WM. L. FABER, Metallurgist and Mining Engineer, (communicated for this Journal by Prof. JAMES C. BOOTH.)*—Having received through Prof. Booth a cobalt ore from Finksburg, Carroll Co., Maryland, which seems to differ essentially from any known mineral, I subjected it to a careful examination, the results of which are given below. It occurs in a vein of copper pyrites, and is accompanied by erubescite, a few points of which exhibited the regular octahedron.

Although crystalline and homogeneous, no distinct crystals were observed ; and the apparent rhombic cleavage was too indistinct to allow of a definite determination. The hardness is 5·5 ; specific gravity =4·58. Lustre metallic, tarnished in some pieces, probably from the presence of magnetic pyrites. Color tin-white, inclining to steel-gray. Streak iron-black. Fracture uneven ; sub-conchoidal in small fragments. Brittle.

Before the blowpipe on charcoal it emits a strong odor of sulphurous acid (and arsenic), intumesces, and melts to a white, brittle and magnetic globule. With borax, soda and microsmic salt it shows the usual reactions of cobalt and copper.

* This communication was received at too late an hour to be inserted as an article.

The chemical composition is as follows:

		Quantity of sulphur required for the metals.	Forming:	
Insoluble (silica),	2·145			
Sulphur,	27·039			
Cobalt,	28·502	16·001	CoS	44·503
Nickel,	1·500			
Copper,	32·988	8·328	Cu_2S	41·316
Iron,	5·311	3·035	FeS	8·346
Arsenic,	1·815			
	99·300	27·364		

Another determination of nickel and cobalt by Mr. J. Hewston, assistant in Prof. Booth's laboratory gave very nearly the same numbers.

The analysis evidently proves that, if the iron replaces cobalt, then Cu_2 is isomorphic with Co and Fe, because there are more than two equivs. of $(Co, Fe)S$ combined with Cu_2S; but that if the FeS be rejected as a mere admixture, then precisely 2 eq. of CoS are united to 1 eq. of Cu_2S, and the isomorphism of Co and Cu_2 is not proved thereby. In order to ascertain whether the FeS was chemically combined with the sulphides of cobalt and copper, a weighed quantity of the mineral, reduced to a fine powder, was subjected to the action of a magnet, by which means 8·769 pr. ct. were separated by repeating the extraction by the magnet four times. The close agreement of this number with that obtained by analysis, 8·346, as the per-centage of sulphide of iron, shows the latter to exist in the mineral only as a mechanical compound; and the substance separated by the magnet being soluble in HCl, while the remaining powder is totally insoluble, the sulphide of iron can only be magnetic pyrites.

As in all cases where arsenic replaces sulphur, such as mispickel, or cobalt glance, one eq. of arsenic ($As=75$), seems to replace two of sulphur ($S=16$); and as there is not a sufficient quantity of the latter to form RS_2 with any one of the metals; the arsenic must owe its presence to the foreign admixture of a mineral R_2As; and since the quantity of nickel found by analysis happens to satisfy the formula Ni_2As, and it is immaterial, from the close agreement of their equivalents, whether the arsenic be combined with nickel or cobalt, the nickel was thus disposed of in the calculation. The true formula of the compound is therefore $2CoS+Cu_2S$.

The substance subjected to analysis consists therefore of a new mineral, which I shall call *Carrollite*,* with foreign admixtures of about 8·5 pr. ct. of magnetic pyrites, and 3·3 pr. ct. of copper nickel, with 2 pr. ct. of quartzose gangue; carrollite consists of—

	By analysis.	Calculated from the formula $2CoS+Cu_2S$.
Sulphur, ...	28·355	28·077
Cobalt, ...	33·256	34·050
Copper, ...	38·389	37·873
	100·000	100·000

* The name is given in memory of the locality whence it was obtained, as well as of a name cherished by every American.

4. *Description of two New Minerals and a New Earth;* by David D. Owen, M.D., (Jour. Acad. Nat. Sci. Phil., vol. ii, Part. II, 1852.—(1.) *Thalite.*—While examining, in the summer of 1848, the North shore of Lake Superior, situated in Minnesota, between Pigeon Point and Fond du Lac, particularly in the vicinity of Baptism River, I observed a peculiar, soft, green mineral diffused in the amygdaloidal traps. Though not in large masses, this mineral was so abundantly disseminated in some of these rocks that the least blow of the hammer indented the rock and left a whitish green mark from the easily crushed particles of the soft green mineral in question.

In the winter of the same year I undertook a chemical analysis of the mineral, and repeated it on several varieties in the year following.

The result showed it to be essentially a hydrated silicate of magnesia, and what appeared to be a new earth, intermediate in its properties between magnesia and manganese.

The color of this mineral when pure is of a pale yellowish green; consistence and hardness about that of wax. Heated in a matrass it gives off water. Heated strongly alone in the forceps it whitens, but does not exfoliate; tinges the outer flame slightly green. In thin splinters it fuses on the edges. With borax it dissolves with difficulty into a transparent bead, which has a greenish tinge when hot. With soda it dissolves but very partially and very slowly. Heated with nitrate of cobalt hardly any color is perceptible. Fused with four times its weight of carbonate of soda and potash in a platina vessel it gives a white enamel, tinged on the edges only of a light blue. Some specimens of this mineral effervesce distinctly with acids; but this is always from impurities. The pure varieties contain no carbonic acid. Specific gravity 2·548. It has not been found crystallized.

Treated with hydrochloric acid, chlorine is evolved, and the greater part of the constituents, except silica, dissolved.

After the separation of the silica and the greater part of the magnesia, there invariably remained a whitish mass, tinged slightly of a reddish yellow or flesh color, which had a tendency to darken in the air; this amounted to 18 or 19 per cent. When this was dissolved in just sufficient hydrochloric acid to take it up, and afterwards boiled with excess of caustic potash, 4·6 per cent. of alumina separated, leaving about 13·5 of matter quite insoluble in that reagent; of this 1·5 per cent. was peroxyd of iron, and about 12 per cent. the new earth above alluded to, slightly contaminated with magnesia.

The analysis of the mineral is therefore as follows:

$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	New Earth	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$	Mn	$\dot{\bar{\mathrm{H}}}$
42	4·6	1·5	10–12	20·5	0·8	*trace*	18

It was found exceedingly difficult to free this earth entirely from oxyd of iron and magnesia. I succeeded, however, in separating the iron by the following process, so that the solution no longer gave the reaction indicative of iron either with hydro-sulphuret of ammonia or ferro-prussiate of potash. The solution was evaporated nearly to dryness, and while still hot a jet of water was thrown on it. By repeating this process several times the oxyd of iron was all precipitated, and could be separated by filtration, though the solution passed with extreme slowness through the filter from the free state of the precipitated oxyd of iron. The magnesia was separated by two methods, either by dissolving the earth in hydrochloric acid, adding sal ammoniac and neutralizing with ammonia, or, by digesting the earth in water acidulated with a few drops of nitric acid. In consequence, however, of the new earth being slightly soluble in sal-ammoniac and in dilute nitric acid some loss is sustained by this method, and therefore it is not applicable to quantitative analysis.

When thus separated this earth has the following properties and reaction with reagents.

It dissolves readily either in hydrochloric or nitric acid, evolving chlorine from the former acid. The solution in hydrochloric acid, when concentrated, has a beautiful pea green color, and the salt crystallizes either of a slightly paler green or a light chrome yellow, depending on the degree of heat at which the evaporation is completed. The peculiar color of its salts together with the appearance of the residue left in the analytical process after treating with caustic potash to separate the alumina was what first attracted my attention to this earth.

The solution of the earth in dilute hydrochloric acid gives the following reactions with reagents:

Ammonia, a white, bulky precipitate, only sparingly soluble in sal-ammoniac. This is one of the characters which distinguish it from magnesia. Oxalate of ammonia, a white precipitate in neutral solutions: another distinction between it and magnesia. Oxalic acid, no precipitate until quite neutralized by ammonia. Bi-carbonate of potash, white precipitate; apparently slightly soluble in excess. Phosphate of soda and ammonia: the vesicular precipitate with this reagent is quite peculiar, and forms one of the marked characteristics of this earth. If the reagent be added without disturbing the fluid, a number of little vesicles are formed, which remain distinct, as if each were enclosed in a delicate translucent membrane. Ferrocyanid of potash, a white precipitate, with a slight tinge of bluish green, which seemed to be independent of any remaining trace of oxyd of iron; perhaps in part due to the color of the reagent itself. Hydrosulphuret of ammonia, a white precipitate. Succinate of ammonia, a white precipitate even in slightly acid solutions. Benzoate of ammonia, the same, with a tinge of yellow. Crystals of sulphate of potash inserted in the solution gave but a very slight precipitate, and that only after long standing. The precipitate of phosphate of soda is soluble only in a considerable portion of muriatic acid, and is not precipitated by boiling.

When separated, and still slightly contaminated with magnesia, the earth has a pale flesh color, not unlike yttria. When freed from the magnesia it has more the appearance of powdered, dried albumen.

The earth differs from alumina and glucina in being insoluble in caustic potash. From magnesia, in producing colored salts; in being only slightly soluble in ammoniacal salts; in the peculiar vesicular character of the precipitate with phosphate of soda; in being precipitated by oxalate of ammonia. From yttria it differs in not giving a precipitate with oxalic acid in slightly acid solutions; in being precipitated by succinate of ammonia, even before the solution is quite neutral, which prevents this reagent being applied to separate iron from it, as is recommended by Berzelius for separating iron from oxyd of yttria. It differs from zirconium, in being soluble in nitric and muriatic acids, after ignition. From cerium, in not turning of a brick red after ignition: and in the color of its salts, which are not amethystine but shades of green and yellow, except the nitrate, which is almost colorless. The nitrate crystallizes in prisms which seem to be right rhombic. Its salt, like the corresponding ones of magnesia, seem to be deliquescent.

The mineral, from which this earth was extracted differs from talc, in the absence of any foliated structure; in not exfoliating before the blowpipe; in giving off water in the matrass, which talc does not, being quite anhydrous, while this is a hydrated silicate. It contains 20 per cent. less silica than talc.

Leaving out of account the earth in question, the chemical constitution of this mineral comes nearest to saponite and soap stone. The specimens of saponite or soap stone analyzed by Klaproth, contain 3 to 4 per cent. more silica; 4 to 5 per cent. more magnesia; 4 to 5 more alumina, and about the same quantity of water and oxyd of iron.

The specimens of saponite from Brusksveden, analyzed by Svanberg, contain 8 to 9 per cent. more silica; 22 per cent. more alumina, and 10 per cent. less magnesia and 8 per cent. less water.

From the green earth often disseminated in the Italian amygdaloids it differs essentially. Most of these contain a large per-centage of oxyd of iron and very little magnesia—2 to 6 per cent. only. Several of the analyses of serpentine and marmolite indicate nearly the same amount of silica as in this mineral, but in them the magnesia is doubled.

Some specimens yielded a fraction of one per cent. of copper, but this is an accidental impurity, like the adhering carbonate; the acid solution of the pure mineral gives with sulphuretted hydrogen a slight milkiness only from a small quantity of precipitated sulphur, caused by the reduction of the small quantity of peroxyd of iron present. The green color of the mineral may probably be attributed to the presence of this peculiar earth which produces green salts.

In consequence of the difficulty in separating the traces of magnesia, without dissolving part of the earth itself, I have not been able to ascertain the exact per-centage of the earth in the mineral, nor yet determine its combining proportion.

From the quantity of chlorine evolved during the solution of the mineral and the earth in hydrochloric acid, it appears that this earth must exist in at least two degrees of oxydation: the chlorine being disengaged, just as in the case of the solution of the higher oxyds of manganese* when treated with hydrochloric acid.

If the small per-centage of alumina and oxyd of iron present be regarded as accidental, it is probable that the constitution of the mineral is: Two equivalents of bisilicate of magnesia and one equivalent of the peroxyd of the earth, with two equivalents of water; or,

$$2\dot{Mg}\,\dddot{Si}^2+NE,\,\dddot{Si}+2\dot{H}.$$

Although most of the water is expelled by a heat below redness, still I think it must be regarded as almost all combined; since the quantity

* The mere trace of manganese present in the mineral will not account for the quantity of chlorine evolved.

obtained is very uniform, and is within a fraction of a per cent. of two equivalents.

From the above I conclude that the earth contained in the mineral, which is nearly insoluble in sal-ammoniac, insoluble in caustic potash, and producing the above reaction with reagents, and green and yellow salts, must either be a new earth or else a modification of some known earth not previously noticed.

The name Thalium is proposed for the base of this earth, Thalia for the earth itself, and Thalite for the mineral from which it is extracted.

(2.) *Kettle River Mineral, resembling Saponite.*—In 1849 Dr. Shumard brought a soft, brittle, pale-green mineral, which was collected from the cavities of an amygdaloid three miles above Kettle River, in Minnesota, which has, when dried, much the appearance and consistence of this silicate of magnesia from Lake Superior. This Kettle River mineral, when first collected, was as soft as butter, but hardened by exposure.

I also made an analysis of this mineral, but found it to contain a much smaller quantity of magnesia, much larger per-centage of alumina, more silica, and none of this peculiar earth. The constituents are as follows:

Matter insoluble in HCl, being silicates of alumina, magnesia and alkali, 85·2,	Comp's'd of	Silica,	52·7
		Alumina, with a trace of oxyd of iron,	20·0
		Magnesia,	4·35
		Alkali and loss,	8·15
Alumina, soluble in HCl,			3·3
Oxyd of iron, "			1·2
Magnesia, "			0·73
Manganese, "			·9
Potash,			·7
Soda,			1·1
Water,			9·

This mineral does not agree exactly with the analysis of any mineral of which I have seen an analysis. It comes nearest in its composition to a variety of Phillipsite from Iceland, analyzed by Damour, except that magnesia replaces the lime in Phillipsite: and this mineral would therefore be a magnesian harmotome.

It differs, too, in its degree of hardness, from Phillipsite, or lime harmotome.

This magnesian harmotome from Minnesota decrepitates before the blowpipe, and fuses to a nearly colorless blebby glass, with a faint tinge of yellow.

The analysis of this mineral gives a slight excess which ought probably to be deducted from the alumina, which being bulky was very difficult to wash clean.

It seemed to exist in the cells of the amygdaloids of Kettle River, in its nascent state, and could be spread with a knife, just like the saponite mentioned by Alger, who states that some of the miners of Brucksved tried to eat it as a substitute for butter.

5. *Hauslab's Crystal-theory of our Globe.*—The theory of M. Hauslab* is opposed to the first principles of crystallogeny. For as crystallization is an accretionary process, the process must begin from the cen-

* See this volume, p. 268.

ter: and if the earth has on the contrary cooled from a state of fusion downward from the surface, a cooling crust commencing the operation, there are no possible conditions under which a simple crystal could be formed out of the whole globe, while a moving molten interior existed. The crystallization would go on variously in different parts of the outer surface, according to the nature of the ingredient which might be cooling. Great structural lines, or cleavage directions might be formed, and these would coincide with the lines of equal tension in the cooling crust, which again would depend on the isothermal lines of the epoch, these being coincident mainly with the magnetic isodynamic lines. But the structural character thus produced, would have in its nature little similarity to the great octahedron of Hauslab, although there might be a similarity in some of the great lines of fracture and the elevations that have consequently originated. J. D. D.

III. Botany and Zoology.

1. *Kunze: Supplemente der Riedgräser (Carices) zu Chr. Schkuhr's Monographie, &c.* Lief. 5. Leipsic, 1851.—This fifth part of Kunze's supplement to Schkuhr's Carices, issued about a year ago, shortly before the lamented author's death, has only now reached us. An index and title-page are furnished, numbered "Bande I, Erste Halfte;" but we presume that the work is here closed, with 206 pages of letter-press and fifty plates. As Carex is a favorite genus with our botanists, we indicate, as we have formerly done, the species illustrated in the present fasciculus, which belong to the North American Flora. These are, *Carex exilis* of Dewey, figured from the specimens given in the first part of Dr. Sartwell's excellent *Carices Amer. Sept. Exsiccatæ*. *C. crus-corvi* of Shuttleworth, forma *orthoclados*, from specimens gathered by Engelmann and Fendler. *C. cristata* of Schweinitz, from Geyer's Illinois and Sartwell's specimens. The form figured has a more slender and lax spike than the typical plant, and is still less distinguishable from *C. lagopoidioides*. *C. festiva* of Dewey, figured from Swedish specimens in the *Herb. Normale* of Fries, part 7, number 82, and from Labrador specimens. *C. aurea* of Nuttall, admirably figured from Dr. Sartwell's, No. 65. *C. Geyeri* of Boott, from Geyer's Oregon collection, No. 332. *C. Rugeliana* of Kunze, and *C. juncea* of Willdenow (C. miser, *Buckley*, C. Rugeliana, *Kunze* in herb. Hook. in part.) Also, probably, *C. lævirostris* of Fries (figured from *Herb. Normale*, part 6, No. 47) is to be enumerated as North American, as *C. utriculata*, Boott, is given as a synonym, although with a mark of doubt. Some corrections are given at the close, most of which have already been indicated in this Journal. A. G.

2. *Pritzel: Thesaurus Literaturæ Botanicæ omnium gentium inde a rerum Botanicarum initiis ad nostra usque tempora, quindecim millia operum recensens.* Leipsic. Brockhaus, 1851. pp. 547, 4to.—A very elaborate and faithful work, which has been several years in course of publication, but which was finished only at the close of the last year. The letter-press is in double columns of small type, of which 350 pages are occupied by the titles of botanical books, or memoirs which have been separately issued; the remainder is occupied

with a systematic arrangement, the names of authors with abbreviated titles being classified according to subjects. A. G.

3. *Martius: Flora Brasiliensis;* fasc. x.—We stated on page 44 of this volume, that this valuable work was likely to go on, now that the great *Historia Palmarum* is finished; but we were not aware that a new part was just then issued; this fasc. x, bearing the date of Oct. 1, 1851. It contains the Brazilian *Verbenaceæ*, elaborated by Prof. J. C. Schauer, who worked up the same family for De Candolle's Prodromus. They occupy 138 pages, and are illustrated by 30 plates (folio), executed in the same superior style as those of the preceding parts. There are besides four more of Martius's *Tabulæ Physiognomicæ*, most beautiful illustrations of some of the richest tropical vegetation of the world.

A. GRAY.

4. *Zoological Notes from the Correspondence of* Prof. AGASSIZ, (addressed to J. D. Dana, and dated Charleston, South Carolina, Jan. and Feb. 1852.)

Genus *Tiaropsis.*—Several interesting Medusæ have been already observed by me here, and among them, the entire metamorphosis and alternate generation of a new species of my genus *Tiaropsis.* Here as well as at the North, I have found Tiaropsis to be the free Medusa of a Campanularia.

Infusoria the larval state of Intestinal Worms.—Although for want of time my investigations on intestinal worms have been limited, I have arrived at one important result. You may remember a paper I read at the meeting at Cambridge in August, 1849, in which I showed that the embryo which is hatched from the egg of a *Planaria*, is a genuine Polygastric animalcule of the genus *Paramecium*, as now characterized by Ehrenberg. In Steenstrup's work on alternate generation, you find that in the extraordinary succession of alternate generations ending with the production of *Cercaria* and its metamorphosis into *Distoma*, a link was wanting,—the knowledge of the young hatched from the egg of Distoma. The deficiency I can now fill. It is another Infusorium, a genuine *Opalina.* With such facts before us, there is no longer any doubt left respecting the character of all these Polygastrica: they are the earliest larval condition of worms. And since I have ascertained that the Vorticellæ are true Bryozoa, and Botanists claim the Anentera as Algæ, there is not a single type of these microscopic beings left, which hereafter can be considered as a Class by itself in the Animal Kingdom. Under whatever name and whatever circumscription, it has appeared or may be retained to this day, *the Class of Infusoria is now entirely dissolved*, and of Ehrenberg's remarkable investigations, the descriptive details alone can be available in future; the whole systematic arrangement is gone.

This result has another interesting bearing: for it shows the correctness of Blanchard's view respecting the *Planariæ—their close relation to the Intestinal worms under the name of Trematoda.* Indeed they belong to one and the same natural group.

Is it not remarkable that the two types of the Animal Kingdom long considered as the fundamental supporters of the *theory of spontaneous generation* should have finally been brought into so close connection; and that one of them—the Infusoria— should in the end turn out to be the earliest larval condition of the other,—the Intestinal worms being the parents of the Infusoria?

Cumæ, the young of Macroura.—With regard to the Crustacea called *Cumæ*, I cannot say positively that this group must as a whole be suppressed. But I can state with confidence, that all the species of that genus which I have had an opportunity to examine alive,—and I have watched three—are young of Palæmon, Crangon and Hippolyte. They were actually hatched from the eggs of *Crangon 7-spinosus*, *Palæmon vulgaris*, and *Hippolyte aculeata*. I have full memoranda upon this subject at Cambridge. The genus Nebalia includes in part at least, embryonic forms, one species of which I have observed here.

IV. Astronomy.

1. *Denial of the supposed New Planet*, (Gould's Astr. Journal, No. 36.)—Professor Challis has announced that he has satisfied himself that the body seen by Gasparis, Dec. 8, 1851, and supposed to be a new planet, must have been *Iapetus*, one of the satellites of Saturn.

2. *Third Comet of* 1851.—On the 22d October, 1851, Mr. Brorsen of the Senftenberg Observatory, discovered a telescopic comet in the constellation *Canes Venatici*. The comet had at one period two tails apparently in the same line; one about 30′ in length very bright, turned from the sun, the other 8′ long, and turned towards the sun.

The following parabolic elements of its orbit have been computed by Mr. J. Breen from the Vienna observation of Oct. 24, and the Cambridge observations of Nov. 4 and 15.

Perihelion passage, 1851, Sept. 30·805968 Gr. m. s. t.

Longitude of perihelion, . .	338° 45′ 31″·1	M. Eqx.
" " node, ...	44 28 49 ·8	Jan. 1.
Inclination, ...	74 0 39	
Log. perihelion distance, . .	9·1493178	
Motion, ...	Direct.	

V. Aurora Borealis.

1. *Great Aurora Borealis of February 19th*, 1852; by Professor D. Olmsted, of Yale College.*—Although full and elaborate descriptions of cases of the aurora borealis, have been so often recited as to render it unnecessary, perhaps, to multiply them further, yet *concise* and *systematic* memoranda of great auroras will still be valuable, for the purpose of comparing the phenomena as seen in different places. In accordance with these views, I will offer the following brief notice of the magnificent aurora borealis which occurred on the night of February 19th, 1852, as seen at Yale College.

This grand display seemed to have been in a course of preparation for several days previous. As early as the morning of the 15th, streamers were seen in the north about day-break. On the evening of the 16th, a northern light was observed, accompanied by a few streamers. The 17th was cloudy and snowy. Wednesday morning,

* This paper was received too late to appear as an article in the earlier part of this number.—Eds.

the 18th, I was awaked at 4 o'clock by a light shining into my chamber, which opens to the northwest. On looking out at the window, saw a dense smoky cloud in the west, waves from the north very grand, all flashing towards the pole of the dipping-needle. Examined the southern sky and found an ill-formed corona around the magnetic pole—arches in the north ragged and serpentine—vapor milky with a slight tinge of red. At 4h. 30m., dark segment in the north 15° high, but gradually sank, and about day-break (5h. 30m.) it reached the horizon. Undulations faintly visible in the north as late as 5h. 50m. No shooting stars seen. In the *afternoon*, sky very clear at sunset—air keen at 19° Fah., traces of aurora in the north before the end of twilight. At 8h. 12m., dusky segment in the north, with very bright but transient streamers, shooting up from very near the horizon across the dark segment.

Grand display of the 19th.—At 7h. dark segment skirting the northern horizon, having on the margin a silvery band with a serpentine outline. Shortly after 7, streamers began to shoot upward from this segment, having that peculiar horizontal movement from east to west, which properly constitutes the "merry dancers."

7h. 5m. Streamers very numerous, but remarkably thin—large crimson columns forming on the east and west, which, together with the multitude of streamers, rush to the pole of the dipping-needle and form around it an ill-defined corona. Luminous vapor flows on beyond, far to the south, reaching at the meridian to within 25° of the southern horizon. Southern boundary of the luminous portion of the heavens not a regular arch but an elliptical curve, being drawn inwards on the east and west. Sky below it of a dark slaty or indigo hue.

7h. 30m. Illumination fading away in the south, but a milky vapor overspreads the northern sky, which lasts until 10 o'clock.

10h. Numerous streamers or fragments of streamers, in wavy horizontal bands, one above another with vacant spaces between them. The parts of streamers present the form of perpendicular striæ, composing together the long wavy bands.

10h. 5m. Flashes begin on the west on the southern margin of the auroral illumination. Course upward.

10h. 10m. Flashes begin on the east, and soon after overspread all the northern sky. Crimson columns rise towards the pole of the dipping-needle and form a semi-corona on the northeastern side of the pole.

11h. New corona formed.

11h. 30m. Flashes all round the corona. Very magnificent. On the west where the flashes come near the southern boundary of the illuminated portion of the sky, they resemble thin spray driven before the wind in a gale.

11h. 50m. Corona still remains but is not perfect.

12h. 12m. Aurora declining, but flashes, upward, still continue.

4h. Dark segment in the north 120°, emitting from the upper margin very grand flashes, especially on the west where they resemble a vast conflagration. The segment gradually subsided, until day-break, when streamers continued to shoot up from the line of the horizon.

The night was very cold. Thermometer at 12 o'clock 7°, at sunrise 2°.

From several obliging correspondents I have received descriptions of this remarkable aurora, as witnessed in different parts of our country; and I learn from the public papers that it was seen also in Europe, but of its appearance there I have received no particulars.

At Machias, in Maine, as I learn from Mr. W. J. Maltby, the exhibition was exceedingly magnificent, beginning, as here, about 7 o'clock, and passing through a similar succession of phenomena. The horizontal bands of broken streamers, "at first one, then two, and finally three" arranged one above the other across the northern sky was noted there as well as here; and the undulations or upward flashes were described as equally grand, and in some cases presented a like appearance of mists driven before a gale of wind. "At eleven (says Mr. M.) the sky was all covered with *pale shooting fires* on all sides of the zenith." These flashes around the corona were observed by me not long after 11. To other observers at a later period there was an appearance of *shooting stars*. It was so represented in the account of the phenomena published in the Springfield (Mass.) Republican. My friend, Professor Dewey, of Rochester University, was so kind as to direct my attention to this statement, which he rightly judged would have a peculiar interest for me, as bearing on the question of the supposed similar origin of the aurora borealis and meteoric showers. I therefore addressed a letter to the editor of the Republican, but learned that the assertion was made on the authority of one of the hands of the office, whose character for veracity might be relied on, yet his want of experience in observations of this kind would hardly entitle his testimony to entire confidence unless corroborated by others. The account given by the young man was, that "about 3 o'clock in the morning, the corona S. and E. of the zenith, shot forth fine meteors." Professor Dewey himself also reports a witness, a member of the Junior Class of the University of Rochester, "a careful, discriminating, and competent observer," whose testimony is as follows: "He was walking with a friend after midnight, in a northerly direction. His companion asked him if he saw that shooting star passing northwards? He replied in the affirmative, having his eyes directed upwards, and the meteor having passed 20° north of the zenith. On turning to the south again, they saw a number of meteors *shoot off from the circumference of the corona*, some south, some west, some north, and in all directions. They appeared in succession, a minute or two apart. He is familiar with the flashes of light seen at times during the aurora, and says the meteors had no resemblance to it. They appeared as bodies or masses shot off from the corona, and had trains after them, though they were not very bright, the auroral light itself being too intense to permit them to appear as bright as in the dark. The number seen in fifteen or twenty minutes was ten or twelve. Next morning, a plain uneducated man asked him if he saw the meteors at 3 or after 3 o'clock, and remarked that there were a great many, and that the show was very splendid.—The place of observation was Wyoming, 20 or 30 miles southwest of Rochester.

I regret to say that at the periods when these meteors were observed, I was in a situation that would have prevented my seeing them had they been visible at this place. At Rushford, in western New York, as I learn by an obliging communication from Ira Sayles, Esq., Preceptor of Rushford Academy, the appearances of the aurora were equally remarkable and splendid as those already described, commencing, as elsewhere, at 7 o'clock. At some of the telegraph stations, the wires were strikingly affected during the presence of the aurora; but I have not been able to obtain any very precise statements of the facts.

I have received from my friend, the Rev. Sylvester Cowles, of Olean, N. Y., the following statement respecting the foregoing aurora as observed by him, which I think ought not to be withheld from the public, although possibly the peculiar appearances which he describes may be thought to have arisen from a mass of fog illuminated by an aurora behind it. Yet it is difficult to account for the apparent emission of sparks or scintillations on any such supposition. Mr. Cowles remarks:—

"I state the facts as they appeared at Olean, Cattaraugus Co., N. Y., in reference to the aurora borealis of the 19th of February last. As the sun set, the atmosphere was perfectly clear. I was returning with my wife from out of town, and was about three miles east of our village at half past six, or twenty-five minutes of seven, (as I judge from the time I arrived at home) when my attention was attracted by a white pillar (cloud in appearance) I should judge two feet square at the base, and six feet high, near a dry pine tree,* say sixty feet from the ground. At a short distance west of it, was another small spar-like cloud of similar appearance. In seeing them so near the earth I instantly directed the attention of Mrs. C. to them, and immediately, as we looked, auroral light began to beam out of them. We were riding due west, and as there was nothing in the appearance of a cloud, or vapor in the west or northwest, I turned and looked east, and saw auroral vapor coming from the east to the west across the valley in which we were. It was very remarkable to us in consequence of its being so near the earth. When it came against us, apparently not over thirty rods from us, it was about half the length of several pine trees which stood in the field, from the ground. There were several of these trees, some were on this side of it, and others were just beyond it, which we could distinctly see, and upon which we remarked at the time. There were no streamers proceeding from it, but a curtain of auroral light slowly passing across the valley, at the distance above stated from the earth. Its course was due west, but at the same time receding to the north. It must have been ten minutes from the time we first noticed it, before it seemed to strike the hill on the west side of the valley. From the base of this sheet, or curtain of light, the most beautiful, brilliant appearance was seen. Masses of auroral light, like off-shoots from a sky-rocket, would fall towards the earth, scattering itself in the air, the largest particles of which would not disappear till they were

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* I state the phenomena just as it appeared to us. The pillar and the cloud both scattered off in the auroral sheet of light as they passed westward. It was beautiful to see them sifting off as it were, till no appearance of cloud or pillar were left.

within a few feet, say eight or ten, of the earth.* It was the most splendid sight I ever beheld. When the sheet, in its progress westward passed over a mill-pond, it was greatly agitated, spread around considerably, with an infinite number of auroral sparks, like electricity, though of the auroral color, illuminating quite a section of the atmosphere. I supposed at the time, it was the effect of the exhalations from the pond, which was not frozen over. After it seemed to strike the western hill it condensed, and appeared so much like fog Mrs. C. said it was fog, but upon being reminded it was too early in the evening for fog, and also pointing her to stars which could be seen through it, she relinquished the idea.† We now came to the woods through which I drove rapidly, nearly one mile and an half, and when we came out it had filled the horizon at the north with the red light which was seen every where."

2. *Aurora Borealis of February* 19, 1852; by Prof. D. Kirkwood, (from a letter to the editors, dated Delaware College.)—Incomparably the grandest auroral display I have ever seen has been observed here this evening. My attention was first called to the phenomena about 20 minutes before 10 o'clock. An unusually heavy auroral cloud extended across the northern horizon, the dark segment rising in the center to an elevation of about 20°. Streamers of extraordinary brilliancy darted frequently almost to the zenith, and sometimes even beyond it. Flashes, or rather waves of lambent light, having an almost flame-like appearance, incessantly succeeded each other in all the northern hemisphere, from the horizon towards the zenith. At 10h. 5m. a column of light from 3° to 4° broad, and having a reddish tinge, shot up from the northwest, *passed precisely over Mars*, and kept its position about half a minute. If this was elsewhere observed it might enable us to determine the elevation of the meteor. Perhaps it may be worthy of remark that a greenish tinge was observed in several luminous spots which broke out from time to time in the auroral cloud.

As I write this hasty note the aurora is gradually fading. The undulations, however, are still distinctly visible.

Friday morning.—I have just been informed that the streamers had not disappeared at 3 o'clock this morning.

VI. Miscellaneous Intelligence.

1. *Zinc Oxyd as a Pigment.*—This branch of industry has already arrived at much importance in this country through the action of the New Jersey Zinc company, whose works are dependent on the red zinc ore and Franklinite so long known to mineralogists. The products of this manufacture are chiefly two, the white oxyd, dry or ground in oil, and of several grades of quality, and the colored pigments formed mainly by grinding the raw ore. The zinc white is made in large oven-shaped retorts

* I remarked at the time to Mrs. C. that it was like the stars, or meteors, though of different color, which fell so plentifully a few years since.

† The stars were seen through the upper edge, or section of the vapor, while the dark appearance of the hill was distinctly seen through the lower part of it.

of brick, around which the heat of an anthracite fire is conducted both above and below. These ovens are very low but of large superficial area. A wide pipe of sheet iron connects each with a very large horizontal tube in which a current of air is kept moving by the revolution of a fan-wheel. This current flows first through the retorts, furnishing air to burn the zinc and means of transportation to the oxyd formed, which is delivered by the current in large cooling chambers. The charge in the ovens is one thousand pounds of crushed red zinc and Franklinite mixed with its own bulk of the dust of anthracite coal. The heat is raised to full redness and so managed as to be hottest on the upper surface of the charge. Reduction of the zinc is probably effected by the action of the hot carbon, but the metal is immediately burned by the atmospheric oxygen drawn in by the mechanical action of the blower before named. All the volatile products of this chemical action are drawn through the large tubes and partly delivered into capacious sacks of closely woven muslin suspended in well ventilated apartments. The heat retained by the oxyd is not sufficient to scorch the muslin. From the proper openings in the sacks the material is collected in casks. In the retorts the residue consists of undecomposed Franklinite and of metallic iron mingled with unchanged carbon. When the best results are obtained the ore yields half its weight of oxyd. This oxyd is never quite pure, as a small quantity of dust and foreign materials are drawn in with the current of air. Dissolved in acetic acid this residue remains on the filter and perfectly pure carbonate of zinc may be precipitated from the acetate. Chemists will regard this as an important means of procuring chemically pure zinc.

It is curious that the carbonate of zinc obtained by precipitation when mingled with oil has no "body," or does not cover the surface on which it is laid, while the anhydrous oxyd obtained in the furnace process covers very well. Water added even in small quantity to the zinc oxyd ground in oil, will cause the whole mass to solidify. The greater cheapness of zinc oxyd, its freedom from poisonous quality, and the fact that sulphuretted hydrogen does not discolor it, are causes which must lead to the general use of this material in place of lead. The New Jersey Zinc Co. are at present manufacturing about 5000 pounds of zinc oxyd daily, from 18 furnaces or retorts, only one half of which are usually in operation at the same time. The colored paints formed by grinding the crude ore, are sold at very cheap rates and found to possess remarkable power to prevent the oxydation of metallic iron.

2. *Thoughts on Telegraphic Communications Twenty years ago;* (communicated for this Journal by Mr. D. A. Wells.)—In 1833, Hon. John Pickering, since deceased, by request of the Boston Marine Society, delivered a lecture on the subject of "Telegraphic Language," tracing the art from the first communications made by torches at the siege of Troy, until the date of the address. In conclusion he makes the following curious reflections and suggestions, which all must acknowledge to border very closely upon the prophetic:—

But the application of the art to other subjects will naturally follow the progress of those rapid improvements which are believed to be characteristics of the present age. If, for instance, we take the case of commercial affairs in general, we know what a change has taken place in the transmission of intelligence relating to business within a few years past; and it would seem too, as if every new impulse in business rendered it necessary to add new energy to our means of communication. Is it too much to suppose that the demands of business may before a long time lead to the establishment of telegraphic communications* between our principal cities? Twelve years ago it was stated in the French papers, that *three thousand* messages could be conveyed in one day from Paris to any extremity of France, and that answers could be received to them. Even since I have been preparing to meet you at this time, the question has been agitated as to the practicability of a telegraphic line for purposes of business between the great seat of one of our northern manufactures and this city. And why may we not look forward to the time, when there shall be such a communication between this city and New York, Philadelphia and Washington? I dare not presume to predict such an event for some time to come; and yet when we daily witness the extraordinary resources of this growing country—when we observe the wonderful results of an active and intelligent population incessantly occupied in developing their powers and resources—and stimulated by the circumstances in which they are placed, to greater and more intense exertion than the same number of people have probably ever been,—when we see too, that all ordinary calculations founded upon the precedents of other nations, fall short of what is here actually accomplished—when we witness all this, we cannot believe that it is being too sanguine to expect the application of the telegraph to a vastly greater extent than we have yet seen. Will it be said that the demands of business will never be such as to warrant the adoption of it, for instance between this city and New York? For want of practical knowledge I dare not affirm that this will very soon be the case; and yet if there are now essential advantages to business in obtaining intelligence from New York in two days or less or at the rate of eight or ten miles an hour, any man can perceive that there may be a proportionate benefit, when we can transmit the same information for that distance by telegraph at the rate of four miles in a minute or in the space of a single hour from New York to Boston. Let us take, as an example by way of illustrating this view of the subject, the case of the great questions now agitated at Washington and in which the welfare of the country is so essentially involved, might it not prove to be of vital importance to thousands of our men of business in this quarter of the Union, whether friendly or adverse to the tariff, to be able to know the decision of the government at Washington, in two hours and a quarter after that decision was made? Why do we annually see such extraordinary efforts made, to transmit the message of the Chief Magistrate, and other state papers and public acts of government through all parts of the country? When therefore we find by actual experience that this rapid mode of communication is deemed necessary to the wants of an active community, who will venture to set bounds to its application? We can in imagination suppose

* Mr. Pickering here refers to the old form of telegraph by which intelligence is communicated from station to station by means of signals.

it to be extended on our coast from one end of the continent to the other; and if any people shall ever carry it from our Atlantic shores across the continent to the coast of the Pacific ocean, I feel the strongest conviction, that it will be accomplished by our countrymen; when we may obtain intelligence from China in as short a time as it now reaches us from Europe.

3. *Halos and Parhelia;* by C. M. TRACY, (communicated for this Journal.)—On Sunday, Feb. 22, 1852, at about 11h. 40m. A. M., a light fall of snow which had continued through the forenoon, cleared almost wholly away; and the sun, being near the meridian, appeared encircled with a clearly defined halo, which showed strong prismatic colors. The estimated diameter of it was 60°. Touching it at its lower side, and vertically below the sun, was an arc of a rather smaller circle, colored like the other, and exterior to it. This arc was perfect some 15° each way from the point of contact, at which point the breadth seemed to exceed that of both circles together, as if an ill-defined parhelion were placed there; and this spot was rather brighter than the rest of the arch. Passing through the sun, and intersecting the first circle on each side, was a broad and beautiful halo of white light, perfect throughout, and of magnificent dimensions. A rather rude measurement gave 120° as its diameter, which appeared to be a close approximation. Taking the sun's altitude into account, it will be seen that this brought its northern limb much beyond the zenith, so that, at first sight, it seemed nearly parallel to the plane of the horizon. Near the points of intersection of the two circles, but exterior to both, were two distinct parhelia, of which the eastern was much more deeply colored, the other being partly hidden by a cloud. I carefully noticed this position of these, as it seemed unusual for them to stand elsewhere than at the points of intersection, but as to the fact, I am quite sure. Much of the atmosphere was clear at the time, and the northern sky was nearly free from clouds.

I did not see the commencement of this phenomenon, but the clouds must have hidden it till nearly the time mentioned. It then began to fade, and before 12 M., had wholly vanished, and did not reappear; so that its duration cannot have exceeded half an hour.

Lynn, Mass., March 4, 1852.

4. *On Fish destroyed by Sulphuretted Hydrogen in the Bay of Callao;* by Dr. J. L. Burtt, U. S. N., (Proc. Acad. Nat. Sci. Philad., vi, 1.)—One occurrence always excited much interest, whenever there was an evolution of sulpho-hydric acid gas (a frequent occurrence) from the bottom of the Bay of Callao. The first premonition of what was to produce a remarkable destruction among fish, was the discoloration of the water of the bay, from a marine green to a dirty milk-white hue, followed by a decided odor of the gas; so much of it being present on many occasions as directly to blacken a clean piece of silver, and to blacken paint work in a few hours.

The fish, during this evolution, rose in vast numbers from the bottom; and after struggling for some time in convulsions upon the surface, died.

I was particularly struck by this fact, that all of them during the time that they were under its influence, acted in precisely the same manner. The first thing noticeable with regard to its effect upon them, was that on coming near the surface, they seemed to have much difficulty in remaining below it at all. They then rose completely to the surface, struggling vainly to dive beneath. This was followed by violent springing and darting in various directions—evidently without control of direction—for they moved sideways, or upon the back, and sometimes tail first, with great velocity. After a little time their motion became circular, and upon the back, the circle of gyration constantly diminishing, and the rapidity of the motion as constantly increasing, until there was a sudden cessation of all motion. The head then floated above the surface, the body being in a perpendicular position. A few convulsive movements shortly followed, and they were dead.

I have watched thousands of them so dying; and in every instance such was the mode of death. Having taken them at the moment of death and immediately after, a rude examination showed in all the same appearance. The intestines and brain were gorged with blood, much darker than natural. The gills were almost black, and the air-bladder ruptured.

5. *Remarks on the Climate of San Francisco;* by Dr. H. Gibbons, (from the California Christian Advocate.)—Since the first of December, 1850, I have kept a record of observations on the weather in this city, of which I propose to give a summary, for the especial benefit of distant enquirers. It may be well to observe, that while the climate of the western coast of North America possesses some peculiar features, that of San Francisco and the immediate vicinity, differs from every other place on the coast, and is, in some respects, the most extraordinary climate in the world. This is owing to the peculiar position of the city, having the ocean on one side, and on the other a vast bay extended north and south near a hundred miles, and separated from the ocean by a mountain wall, except at the break where the city is located, and where the bay communicates with the sea by a narrow strait. On the coast, a trade wind from the northwest blows almost constantly, in the summer season especially, and a strong ocean current flows in the same direction.

The thermometrical observations forming the basis of the following summary, were made three times a day, viz.:—about *sunrise*, which is the coldest period; at *noon*, or after, being the warmest period; and at *eleven* in the evening. In computing the mean temperature for the month, I have used two observations only, the extremes at sunrise and at mid-day; experience having shown that the mean thus calculated is very nearly the true temperature for the twenty-four hours.

In the Atlantic States, the warmest period of the day in winter is from one to two o'clock, and in summer from two to three. In San Francisco the same rule holds in winter but not in summer; for the sea breeze, which springs up about noon, or soon after, instantly depresses the temperature, so that the warmest time of the day from May to August inclusive, is an hour or two earlier than in winter.

From the want of proper care in the location of the thermometer, many of the observations which are thrown into print lose much of their value. The greatest error is commonly at mid-day, when the instrument is exposed to reflection from buildings and other objects on which the sun is shining. Every such object acts as a mirror, and tends to elevate the column of mercury above the proper mark for the air. The thermometer should therefore be excluded, not only from the direct, but also from the reflected heat of the sun, and it should at the same time be exposed to a free circulation of air; hence to obtain a proper location is often very difficult. The figures in my observations will be found lower, in many instances, than those obtained by other observers, in consequence of the care exercised in this respect. In making the morning observation, I use a self-registering thermometer, which is certain to give the minimum temperature.

The table, which I will now present, gives the mean for each month at or before sunrise, when it is the coldest, at or after noon, when it is warmest, and at eleven in the evening; the mean temperature of the month, computed from two daily observations; also the warmest and the coldest mornings in each month, and the warmest and coldest days at noon, with the range of the thermometer. It embraces a period of fourteen months—from December, 1850, to January, 1852, inclusive.

	Sunrise.	Noon.	11 P. M.	Monthly mean.	Coldest morning.	Warmest morning.	Coldest noon.	Warmest noon.	Range.
December, 1850, ...	43·29	54·13	45·39	48·71	28	54	38	64	36
January, 1851, ...	41·68	56·94	44·90	49·31	30	56	50	64	34
February, ...	41·97	60·03	43·64	51·00	33	52	55	71	38
March, ...	44·00	63·68	44·84	53·84	34	50	53	74	40
April, ...	48·20	67·27	49·80	57·73	42	56	57	84	42
May, ...	49·58	64·32	50·42	55·95	45	54	57	71	26
June, ...	50·90	66·73	51·80	58·81	49	56	60	78	29
July, ...	51·50	64·32	52·10	57·91	47	54	60	73	26
August, ...	54·97	69·45	56·06	62·21	50	66	63	82	32
September, ...	53·97	69·27	54·20	61·62	50	63	64	75	25
October, ...	53·36	70·42	55·45	61·89	47	60	60	83	36
November, ...	48·93	63·60	51·90	56·26	41	57	52	73	32
December, ...	46·10	56·55	48·26	51·32	35	58	51	61	26
January, ...	44·61	56·97	49·39	50·79	35	52	50	64	29
Year, ...	48·76	64·38	50·28	56·57	30	66	50	84	54

The average yearly temperature at Philadelphia is 51·50. Two degrees south of Philadelphia, in the latitude of San Francisco, it is near 54. It follows that the yearly temperature, at this point of the Pacific coast, is not much higher than on the Atlantic border. The vicinity of the Golden Gate is much colder in summer than any other point on the Pacific coast, south of the Columbia River; owing to the almost incessant sea breezes, induced by the geographical features of the region round about.

The most striking peculiarity of the climate of San Francisco is its uniform temperature. There are no extremes of heat or cold. The warmest day in the year was the 28th of April, when the mercury reached 84: next to this was the 19th of October, 83. On the 18th of August it was 82, but this was *the only day in the three summer months* when it rose above 79! The thermometer was at or above 80 only on nine days in the year, six of which were in October. At Philadelphia it reaches this point on from sixty to eighty days in the year.

Only once in the year did the mercury sink to the freezing point, and it was below 40 only on twenty-five mornings. At Philadelphia it falls to the freezing point, or lower, about 100 times in the year.

The coldest day in the year, at noon, was 50. This is about equal to the *warmest* weather in the three winter months at Philadelphia. There, the months of January and February sometimes pass without one day as warm as this.

The warmest month in the year, at sunrise, was August; then September; then October. July, which is decidedly the hottest month in most other climates, was the fourth on the list, being considerably colder than October.

The warmest month at noon-day was October; then August, September, April and June, in the order named. July comes in with May, being the sixth on the list, and only a trifle warmer at noon-day than March and November.

At 11 P. M. August was the warmest, and next comes October and September, before July, which is but a trifle warmer at this hour than November. November was warmer in the evening than June.

The lowest temperature in the year being 30, and the highest 84, it follows that the range of the thermometer was 54. On the Atlantic border, in the same latitude the range is nearly 100. At Philadelphia the greatest cold is 10 below zero, and the greatest heat 94; making a range of 104. At San Francisco, in December, 1850, the thermometer was one morning as low as 28 degrees, and did not rise above 38, at noon, so that ice remained in the shade all day. This was regarded as an extraordinary degree of cold. Up to the present date, February 25, 1852, the extreme cold of the winter has been 35, and it is probable that the coldest weather is past.

January is the coldest month of the year in the Atlantic states, and February a trifle warmer. The same is true of San Francisco, judging from the past year. The temperature of January, at Philadelphia, is about $30\frac{1}{2}$, and of July, the warmest month, $73\frac{1}{2}$; difference 43 degrees. The difference between January and August, the coldest and warmest months at San Francisco, was not quite 13 degrees.

For facility of comparison, I insert the mean temperature for a series of years of the several months at Philadelphia;—January $30\frac{1}{2}$, February $31\frac{3}{4}$, March 40, April 50, May $60\frac{1}{2}$, June 69, July $73\frac{1}{2}$, August $71\frac{1}{2}$, September 64, October 53, November $42\frac{1}{2}$, December $33\frac{3}{4}$. By observing that one degree of latitude makes about one degree of difference in temperature in the Atlantic States, the reader may easily compute from these data, the mean temperature at any given place. For example, if the place be two degrees north of Philadelphia, you will find its mean temperature by deducting two from the temperature at Philadelphia; if south by adding.

The coldest month in 1851, at San Francisco, (viz. January) was nine degrees warmer than the average of the coldest month at Philadelphia: while August, the warmest month at San Francisco, was eleven degrees *colder* than the average of July, the warmest month at Philadelphia.

At San Francisco, the temperature falls more rapidly in the afternoon and evening than in the Atlantic States, but less rapidly during the night. From 11 P. M. to sunrise, the mercury at Philadelphia falls four or five degrees on the average, while at San Francisco the difference was less than two degrees, and in four of the months less than one degree; except in the winter, when the change is similar in this respect at the two points. In November, December and January, at San Francisco, the thermometer falls from two to three and a half degrees between 11 P. M. and sunrise. The same is true precisely of Philadelphia. But while at Philadelphia in all the other months the fall during the same period of the night is twice as great, it is less than half as much at the former place. In other words, the temperature falls in the night after 11 P. M. four times as much at Philadelphia, as at San Francisco, from February to September inclusive.

In the summer months, there is scarcely any change of temperature in the night. The early morning is sometimes clear, sometimes cloudy, and always calm. A few hours after sunrise the clouds break away, and the sun shines forth cheerfully and delightfully. Towards noon, or most frequently about one o'clock, the sea breeze sets in, and the weather is completely changed. From 60 to 65 the mercury drops forthwith to near 50, long before sunset, and remains almost motionless till next morning. This is the order of things in three days out of four in June, July and August. May and September exhibit a degree of the same character, the sea winds establishing themselves in the former and declining in the latter month. This subject will be more fully investigated under the head of winds.

The remarkable uniformity of temperature at San Francisco, may be further illustrated by taking note of the number of days in the year which give the same degree. The most frequent temperature at sunrise was 53, the mercury standing at that point on forty-five mornings. The most frequent at noon was 64, forty-two days showing that temperature. Referring to my journal kept at Philadelphia, I happened to open at the year 1839, which exhibits a fair representation of the climate there. I find the most frequent temperatures at sunrise were 52 and 68, but that the mercury stood at each of these points on fourteen mornings only. The greatest number of days in the year coinciding in temperature at noon was sixteen, with the thermometer at 68.

At San Francisco, in the year 1851, there were one hundred and sixty-one mornings with the temperature from 50 to 54 inclusive. At Philadelphia the greatest number of mornings within the like range of the thermometer, in the year 1839, was but forty-six. At the former place there were two hundred and nineteen days within a range of 5 degrees at noon, while the greatest number within that range at Philadelphia was but sixty.

It is not uncommon for the thermometer at noon to stand almost at the same point day after day, for one or two weeks. March, April, and October, were the most irregular months in this respect, being interspersed with a great proportion of warm days. But no other month of the year elapsed without exhibiting one or two weeks continuously when the mercury varied only five degrees. From the 12th to the 26th of February (15 days), the lowest mark at noon-day was 55, and the highest 60. From the 2d to the 16th of June (15 days), the lowest was 65, and the highest 70. From the 1st to the 13th of July (13 days), the lowest was 61; and the highest 65; and from the 17th to the 27th of the same month, the lowest was 60, and the highest 65. In the first 13 days of August, the lowest was 63 and the highest 65, —a variation of only two degrees. From the 13th to the 21st of September, the lowest was 65, and the highest 66; only one degree of variation in nine days. From the 2d to the 11th of November (10 days), the range was between 62 and 67, and from the 14th to the 24th (11 days), between 60 and 65. From December 8th to the 24th (15 days), the variation was from 54 to 58, only four degrees.

The sudden fluctuations of temperature incident to the climate of the Atlantic States are unknown here. We have none of those angry outbreaks from the northwest, which change summer to winter in a few hours. But the diurnal depressions of temperature in the afternoon are considerable. The average fall of the thermometer from noon to 11 P. M., for the whole year, is at Philadelphia 11 degrees; at San Francisco 14. The change at the latter place is the more striking, from its greater rapidity. In the season of the sea breezes, a few hours will reduce the temperature fifteen, twenty, and on some of the warmest days, twenty-five degrees; and this change is effected long before sunset. Under the head of *winds*, this subject will be more fully examined.

Comparing one day with that succeeding, the difference is never great. The greatest difference during the year at noon, between two adjoining days, was 21 degrees. Turning to the table for 1839, at Philadelphia, in the month of March alone, there are three instances exceeding this: the differences being in one case 29, in the second 33, and in the third 35 degrees. Though no other month was equal to March in this respect, yet there were several other examples during the year, which exceeded the extreme at San Francisco.

As regards the influence of the seasons on vegetation, the common order is reversed. The entire absence of rain in the summer months parches the soil, and reduces it almost to the barrenness of a northern winter. The cold sea winds of the summer solstice defy the almost vertical sun, and call for flannels and overcoats. When the winds cease, as they do in September or October, comes a delightful Indian summer. In November and December the early rains fall, and the temperature being moderate, vegetation starts forth, and mid-winter finds the earth clad in lively green and spangled with countless flowers. The spring opens with genial warmth, but just as the April sun begins to give promise of summer heat, its rays are shorn of their power by the winds and mists of the Pacific.

These remarks apply only to a small portion of the State of California. Beyond the influence of the Bay of San Francisco and its outlet, the sea winds are scarcely perceptible, even near the ocean. In a subsequent chapter, I will present the results of my observations on the winds, clouds, rain, and other phenomena of the climate, as noticed at San Francisco, together with some notes on the climate of other portions of the State, and also its general relations to health.

6. *Resuscitation of Frozen Fish*, (Scientific American, vol. vii, No. 22.)—We have received a great many communications on this subject, all of them corroborating the statement, "frozen fish will come alive again when placed in a tub of water." Quarterman & Son, of this city, [New York,] inform us that the fish in the streams of Westchester County, N. Y., are frequently caught, thrown out, left to freeze, and are resuscitated when thawed. Mr. Cummings Martin, of Taftsville, Vt., caught suckers out of White River, Vt., flung them on the ice,

allowed them to be there for hours until they were apparently frozen through, and would rattle in the basket like pine knots. When thawed out in cold water, they would wriggle and move about as good as new. J. H. Bacon, of Westchester, Mass., says he has taken tomcod out of the river, allowed them to freeze, carried them to Boston and has seen them come alive when thawed. William Rummel, of Jersey City, N. J., caught some perch in the Hackensack river, in 1836, which froze quickly, he carried them to market which was very dull, he then packed them in snow for three weeks, and after this, when applying pump water to them, every twenty-five in thirty swam about in the tub. He says if fish be frozen in moderate weather, and take a long time to do so, they will not return to life. Robert Pike, of Wakefield, N. H., says he has caught brook trout in January, which froze through in a few minutes, and which, after five hours, when he took them home and put them in a tub of cold water, swam around quite lively. Thomas Power, of Hudson, N. Y., says he has seen fish which were frozen as hard as rock come to life when thawed in cold water. The fish were yellow perch found in the Hudson river. D. H. Quail, of Philadelphia, noticing the statement of Prof. Lathrop, says he has caught fish in New Jersey, near Fortescue's Beach, in Delaware Bay, in winter, in the following manner, which is interesting: he says, "having procured a small boat, we dragged it into the ponds that were formed on the marsh by high tides, and which were frozen over nearly hard enough to bear the boat; then commenced the sport; one would stand in front to break the way, another push the boat along, the third with a small crab net would scoop up the fish which could be seen upon the bottom frozen as stiff as bones—they were all large perch. I caught half a bushel, which, when taken home and put into a tub of cold water from the well, in a short time were swimming about quite lively. Mr. B. M. Douglass, of East Springfield, Conn., says he has caught perch, pickerel, trout, and carp, in winter, allowed them to freeze, carried them for miles, and when thawed out in well water, not one in six but would come to life. He adds, they can be carried to any distance if kept frozen, but if not frozen quickly after being caught, "they will not come too," this he has always noticed. By this, it appears, that if a considerable time elapses between the period when the fish is taken out of the river and thawed they cannot be resuscitated.

Ransom Cook, of Saratoga, N. Y., a very observing man, adds a new fact to this store of information on the subject. He says, that all fish which have been frozen and resuscitated, have their sense of sight destroyed—they all become blind.

7. *The Climatology of Arctic America in reference to the fate of Sir John Franklin*, (Edin. New Phil. Jour., Jan., 1852, lii, 180.)—"The idea of a cycle of good and bad seasons has often been mooted by meteorologists, and has frequently recurred to my thoughts when endeavoring to find a reason for the ease with which at some periods of Arctic discovery navigators were able to penetrate early in the summer into sounds which subsequent adventurers could not approach, and to connect such facts with the fate of the discovery ships. But neither the periods assigned, nor the facts adduced to prove them by different writers, have been presented in such a shape as to carry conviction with them, until very recently. Mr. Glaisher, in a paper published in

the Philosophical Transactions for 1850, has shewn, from eighty years' observations in London and at Greenwich, that groups of warm years alternate with groups of cold ones, in such a way as to render it most probable that the mean annual temperatures rise and fall in a series of elliptical curves, which correspond to periods of about fourteen years, though local or casual disturbing forces cause the means of particular years to rise above the curve or fall below it. The same laws doubtless operate in North America, producing a similar gradual increase, and subsequent decrease of mean heat, in a series of years, though the summits of the curve are not likely to be coincident with, and are very probably opposed to those of Europe, since the atmospherical currents from the south, which in a period raise the annual temperature of England, must be counterbalanced by currents from the north or other meridians. The annual heat has been diminished in London ever since 1844, according to Mr. Glaisher's diagram, and will reach its minimum in 1851. It can be stated only as a conjecture, though by no means an improbable one, that Sir John Franklin entered Lancaster Sound at the close of a group of warm years, when the ice was in the most favorable condition of diminution, and that since then the annual heat has attained its minimum, probably in 1847 or 1848, and may now be increasing again. At all events, it is conceivable that, having pushed on boldly in one of the last of the favorable years of the cycle, the ice, produced in the unfavorable ones which followed, has shut him in, and been found insurmountable; but there remains the hope that if this be the period of the rise of the mean heat in that quarter, the zealous and enterprising officers now on his track will not encounter obstructions equal to those which prevented their skillful and no less enterprising and zealous predecessor in the search from carrying his ships beyond Cape Leopold."—*Sir John Richardson.*

8. *Optical Investigations occasioned by the Total Eclipse of the Sun on the 28th of July*, 1851; by Dr. v. FEILITZSCH. Greifswald, 1852: Th. Kunike, (from the Lond., Edinb. and Dublin Phil. Mag., March, 1852, p. 232.)—The author was one of the numerous band of observers who planted themselves within the moon's shadow upon the day above mentioned. His place of observation was Karlskrona in Sweden. He traces the doubt and mystery which have hitherto enveloped the phenomena attendant upon solar eclipses, to the fact, that they were observed solely by astronomers, and not by physicists. This remark appears to be scarcely applicable where such men as Professor Airy are concerned. Surely the man whose investigations on optics have won him such high renown is not likely to fall into the error of regarding the phenomena in question as lying beyond the limits of physical explanation, or of forgetting the possible influence of diffraction and interference in their production.

Grounding his views on the theory of undulation, the aim of the author is to show that the corona, the colored light, and the red projections from the moon's rim during a solar eclipse, are all the production of diffraction and interference: the results of his inquiry, which certainly evinces considerable ingenuity and a patient study of the phenomena, are as follows:—

The corona observed from the absolute shadow of the moon owes its existence to the diffraction of the sun's rays at the moon's edge.

The colored fringes, caused by interference, exterior to the shadow, are the origin of the various colors observed on clouds during a total eclipse, as also of the colors which precede and follow the total occultation.

The colored light observed during the total eclipse is the light reflected from the colored atmospheric envelope which immediately surrounds the absolute shadow.

The dark, bright, and oblique-directed radiations of the corona are phenomena of interference, due to diffraction by the mountains on the moon's edge, when these mountains lie in or near the line which connects the observer with the sun.

If, however, these mountains are peculiarly shaped, or if they lie outside the above line of connection, the light diffracted by them creates the appearance of the red projections.

The red color of the projections, and of the surfaces which appear detached from the moon's rim, and the increase and decrease of the projections according to the relative position of the sun, moon, and observer, are due to the deportment of the light sent to the observer from the ether particles in free space, when these particles, through the interference of the light diffracted on the mountains at the edge of the moon, are more strongly excited than the neighboring ones.

9. *On the accidental colors which result from looking at white objects;* by M. D. M. SEGUIN, (Comptes Rendus, Dec. 8, 1851, from Lond., Edin. and Dub. Phil. Mag., Jan., 1852, p. 77.)—(1.) If after having looked for some time at a white object the eyes are closed, a colored image of the object is seen. This image presents a number of colors, which change little by little. As an example, I will narrate the following instance. After looking at a very brilliant object, such as a white screen seen by the transmitted light of the sun, on closing the eyes the image appears at the first moment green, olive-green or yellow; but there is a red border all round, followed by much darker tints. After a few moments the image becomes decidedly yellow, but the colored border approaches towards the centre of the image: the latter acquires a deeper yellow, a zone of orange and a zone of red gain gradually upon the yellow, and at the same time the dark tint which was beyond the red separates into a number of colored zones of great intensity, presenting violet, indigo, blue, green. All the colors advance one after the other towards the centre of the image, which they successively occupy.

By varying the brightness of the object, and the length of time of looking at it, I have been able to detect one or two constant series of colors, apparently very different, which these accidental images present.

(2.) When the accidental image is formed in the eye, if they are opened towards a white surface, the image remains; but it generally passes from the tint which it has to one of those which it would assume at a later period if the eyes were kept closed, and at the same time the tints which still remain at the border advance more towards the centre, which they occupy successively. The white light which enters the eye has therefore the effect of accelerating the progression of the colors from the circumference to the centre of the image. I have traced this influence of the exterior white light, whether by opening the eyes before a surface more or less lighted, or by gradually opening them, and I have found that the tint to which the image passes is more advanced in the series when the exterior light is more intense.

(3.) My experiments have enabled me to observe those instances in which the accidental image of a white object passes through alternations of brightness and darkness; I have always observed that the images are colored.

In the hope of being able to account for these effects, I have entered upon the study of the accidental images produced by colored objects. This part of the question has been much disputed. I have repeated almost all the experiments described by various authors, and have frequently been astonished at the results which I have obtained. I shall describe these in a second memoir.

10. *On the difference of Temperature of the Earth and the air immediately above it;* by M. Rozet, (L'Institut, No. 948, p. 69.)—M. Rozet gives the following as the result of his observations at Gap during the summer of 1851. One of his thermometers was placed a centimeter below the soil, and the other in the shade a metre above it. During the clear days of June, July and August, the two thermometers stood at the same height at sunrise. From this time, that in the soil gained upon the other and reached its maximum at about 2 P. M., when it stood 14° above the other. From this, the mercury descended again, so as to stand 1 or 2° above the thermometer in the air at sunset, from which it slowly came into coincidence with it at sunrise again. The amount of difference varied with the temperature, and was less during cloudy than during clear days; and if the day varied from clear to stormy and the reverse, it was indicated by a bend in the curve of coördinates for the day. Sometimes during a rain, the soil was found to be lower than that of the air; but this was only for a short time.

11. *Extraordinary Spots on the Sun;* (Lond., Edin. and Dub. Phil. Mag., Jan., 1852, p. 78.)—On Saturday last, the 29th of November, the solar maculæ, which have of late been very numerous, assumed a remarkable shape and occurred in very considerable number. Dr. Forster, who has been occupied of late in taking drawings of these spots, observes that he has never seen any spot on the sun's disc so large or unusual in form as that which occurred on Saturday: it was of a long and irregular form, densely black, and surrounded with a widely-spreading greyish margin, as well as by several other smaller *maculæ.* Many other more round and compact spots appeared on other parts of the disc. But the most remarkable circumstance was the rapid changes observed in these phenomena. While Dr. Forster was observing them, several new spots broke out into view.

The connection of these phenomena with the abundance of wet and cold were formerly noticed by the late Dr. Herschel. Now that the weather has been dry in England, a more than ordinary quantity of snow and rain has fallen on the continent.

Bruges, Dec. 5, 1851.

12. *Observations on a Red Snow, which fell in Switzerland on the 3d and 4th of February;* by M. Ehrenberg, (Monatsber. Berlin Acad., March 6.—This red snow covered a large extent of country, including Zurich, Berne, Schwyz, Lugano, Bergamo and Milan. It afforded a red precipitate which yielded on analysis a large quantity of lime and

silica, a little alumina, and some iron and magnesia. Microscopically examined, it was found by Ehrenberg to contain 63 organic forms, allied to those heretofore found by him in atmospheric dust, without any marine species.

13. *Declination and Inclination of the Magnetic Needle at Paris*, (L'Institut, No. 940.)—On the 16th of November, 1851, at $1^h\,2^m$ P. M., the declination of the needle at the Paris Observatory, in the pavilion situated at the south extremity of the terrace, was $20°\,25'\,0''$; and on the 20th of November, 1851, at $2^h\,30^m$ P. M. the inclination observed with a compass and two needles of Gambey, gave as the mean of several determinations, $66°\,55'$. According to the results obtained at the Observatory during the preceding fifteen years, the annual diminution in the inclination is very closely $3'$. The mean of the results gave the inclination $67°\,9'$ for the 1st of January, 1841.

OBITUARY.

WILLIAM THOMPSON.—The friends of science will be pained to learn the death of Mr. William Thompson of Belfast, Ireland. Having gone to London for the purpose chiefly of making arrangements for the approaching meeting of the British Association in Belfast, he died there suddenly on Tuesday, Feb. 17, 1852, in the forty-seventh year of his age. At the time of his death, Mr. Thompson was President of the Natural History Society of Belfast, and one of the Vice Presidents of the British Association for the Advancement of Science. He was an early friend of the Association, and took a deep and active interest in all the objects which it sought to accomplish. Though all branches of Natural History received his careful attention, it was to zoology that he devoted himself with the greatest ardor. His various papers published in the Annals and Magazine of Natural History, attest his great diligence and the value of his labors in this department of science. In this view the following publications of his deserve special notice: two "Reports on the Fauna of Ireland,"—the first on the Vertebrata, read before the British Association, and published *in extenso* in the Proceedings of 1840; the second on the Invertebrata, in 1843;—and "The Birds of Ireland." The Birds of Ireland form the first part of a great work which he had planned on the Natural History of that island. It is understood that another portion of the work, the Fishes, was nearly ready for the press. Previous to his death, Mr. Thompson had made arrangements by will for the publication of his manuscripts in the event of his not living to complete his great undertaking. The manuscripts are in charge of two gentlemen of Belfast, and they will be given to the world without unnecessary delay.

VII. BIBLIOGRAPHY.

1. *Knapp's Chemistry Applied to the Arts and Manufactures.* Vol. III. London and New York: H. Bailliere. 8vo, pp. 458, with 9 copper plates.—The third volume of Knapp, in its English dress, is, we understand, in advance of the German issue. It treats of those branches of chemical industry including the production of food and related to agriculture. WATER forms an appropriate introduction to these topics.

Both in England and the United States, much attention has lately been bestowed on the interesting questions connected with the supply of water to cities. Numerous analyses of waters are quoted in this chapter, which would have been more complete had some notice been taken of the researches in the United States on the sources of supply for New York, Philadelphia, Boston, and other places, which have been neither few nor unimportant.

The paragraphs on the preservation of ice will also appear very meagre to American readers. Some of the statistics of so considerable an industry should have been given under this head.

Other subjects discussed in this volume are milk, butter, the preparation of meat, corn, wheat, the potato, tea, coffee, chocolate, tobacco. In an appendix devoted to the preservation of meats, notice should have been taken of the very valuable process of Gael Borden, by which his "meat biscuit" are prepared—a product which received a Jury medal at the Great Exhibition of the industry of all nations, and was esteemed the most important discovery in its class.

The second section of the book treats of technological processes connected with agricultural industry, e. g., MILLS in general, *Bread*, its preparation, fermentation, baking, adulteration, &c. *Starch* from various sources, with the apparatus used in its manufacture, is fully discussed.

The sugar manufacture occupies nearly half the volume, and is handled in a very satisfactory way. Nothing can surpass the beauty of the illustrations in this volume, even transcending those in other parts of M. Bailliere's Library of illustrated Scientific Works. The colored engravings at the close of the volume relating to the sugar manufacture are fine examples of mechanical drawings, but not superior to the effective wood cuts so liberally bestowed in the text.*

2. *An Introduction to Algebra, being the first part of a Course of Mathematics, adapted to the method of instruction in the American Colleges;* by JEREMIAH DAY, D.D., LL.D., late President of Yale College. A new edition, with additions and alterations; by the author, and Professor STANLEY, of Yale College. Durrie & Peck, New Haven.—In regard to a work so well and widely known as Day's Algebra, it is scarcely necessary to do more than notice the fact of its revision, and describe the alterations which it has undergone. The old stereotype plates having become impaired from long and constant use, it was necessary to renew them; and the author resolved to take the opportunity, thus presented, for making a revision of his work, in order to adapt it to the present state of instruction in our Colleges. It is not surprising, certainly, that some changes should have become necessary in the long period of half a century, which has elapsed since the first appearance of this text-book, and has witnessed such extensive changes in our Colleges and other educational institutions. It is surprising rather that the work, unaltered as it has been, should have continued to be generally regarded, in spite of some acknowledged deficiencies, as the most

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* As this volume will probably not be reproduced in this country because of the great number and expensiveness of its drawings, it may be interesting to our readers to know that it may be had for \$5 of M. Bailliere, 290 Broadway, N. Y., while the other volumes of the same series sell for \$4 each.

convenient elementary text-book of Algebra: and that it should be found possible now, to supply these deficiencies in a manner abundantly satisfactory, without altering in any essential point the character of the work. This fact affords a striking attestation of the skill and judgment with which the work was composed; and proves that it must have been a great advance upon the time in which it first appeared.

In making the proposed revision, Dr. Day engaged the services of Mr. Stanley, Professor of Mathematics in Yale College. Mr. Stanley, however was prevented, by necessary absence in Europe, from going through with the entire revision. He had completed the chapter on Simple Equations, when it was thought expedient for his health that he should spend some time abroad. He returned, however, before the work, which in the mean time was continued by the author, had arrived at its conclusion: and the long and highly important sections on the theory and resolution of equations are from his pen. We would direct the particular attention of teachers, and others interested in this subject, to this part of the revised edition. The most serious deficiency of Day's Algebra, as felt and complained of by many who acknowledged its distinguished merits, was the want of a sufficiently copious and extended discussion of the theory of equations. This subject has been for some time assuming greater interest and importance in the view of teachers, and claiming for itself a larger share of space in the text-books, until, perhaps, it has gone a little beyond its proper limits, and encroached upon the rights of other subjects. However this may be, we are certain that the sections just referred to, on the General Properties of Equations, and the Resolution of Equations, containing as they do from sixty to seventy pages, furnish all that can with any reason be regarded as desirable in an elementary treatise. These subjects are handled here with unusual tact, simplicity and clearness. It would not be easy to do more to smooth the progress of the student through discussions, which to many students of Algebra will always present very great and serious difficulty. Thus in regard to Sturm's Theorem, a very remarkable method for ascertaining the number and position of the real roots of an equation, which since its discovery has found its way into many text-books of Algebra, and which is admirably exhibited by Professor Stanley, it may be feared that a number in every large miscellaneous class of college students would fail to master thoroughly a discussion, which is of necessity so protracted and so abstract; but we are confident, that every thing has been done for them, which could be done by distinct and orderly arrangement, by consistent and perspicuous expression, and by copious illustration. Whatever difficulties may remain, they are not the fault of the writer, but are inherent in the very nature of the subject.

We would direct attention also to the section on the Binomial Theorem. In the original work, this theorem was merely inferred from the analogy of particular cases, without any general demonstration. This deficiency the author has himself supplied in the present edition, with his characteristic clearness and simplicity.

The doctrine of Permutations and Combinations has been introduced in a brief sketch, as a necessary preliminary to the demonstration of the Binomial Theorem.

Among the less extensive additions to the work, we may specify the method of multiplication and division by detached co-efficients,—the calculus of imaginary quantities, taken from the notes into the text,—the general properties of quadratic equations—and the value of the symbol $\frac{0}{0}$.

Some changes have been made in the arrangement. Division by polynomial divisors, which was before reserved to the latter part of the work, is now brought under the general subject of Division near the beginning. The methods for elimination in equations of two or more unknown quantities are brought in after Simple Equations, and problems involving two or more unknown quantities are inserted under Quadratic Equations.

There is only one important retrenchment to be noticed. The section on the Equation of Curves has been omitted, as the subject is now studied in most of our Colleges in the extended treatises of Analytical Geometry.

The matter added to the work is thus much more considerable than that which has been withdrawn from it; and the number of pages has risen from 330 to 400. The work, however, in this augmented form, is not more extended than the majority of text-books on the same subject; nor more extended than the present condition of collegiate instruction in this department appears to render necessary. If any institution should find more in the book than its own wants require, it would be easy to omit the more advanced sections; the other portions of the work have still the same elementary character as before.

The essential features of this Algebra and its characteristic excellences are perfectly retained under all the alterations which have been described. Those who are already familiar with the work, or with other productions of the same author, will be slow to suspect him of injuring his own plan by inconsiderate or ill-advised additions and alterations. We can say too with the fullest confidence, that Professor Stanley has wrought out the portions which he has contributed, in perfect consistency with the spirit and method of the original work. There is no appearance of compilation—of botching heterogeneous and ill-assorted elements; the unity of the work is maintained from beginning to end. Everywhere we find that admirable method, which has been justly regarded as the highest excellence of this Algebra. It still presents, in all its parts, the same faithful elaboration, the same conscientious thoroughness. There is no sign of haste or thoughtlessness or forgetfulness. Every part is equally exact and finished. Everywhere we trace the hand of one, who has begun by thinking through his subject, and mastering it as a whole, and who is able thus to finish every part with reference to every other and to the general whole. Nothing is passed over slightingly, because less interesting to the writer. Nothing is left obscure from want of harmony in phraseology and method between different sections.

Another distinguishing excellence of the Algebra is its judicious fullness of statement. Every process of development and reasoning is worked out patiently and distinctly through all its successive steps. Some may perhaps regard this as a disadvantage, and may hold that a more compact and abbreviated style would have been preferable. There have been text-books, composed, some of them, by very able authors, in which the reasoning was barely indicated; the leading steps only being given, while everything else was left to the ingenuity of the learner. Such works have not generally met with much acceptance: they have been found, it would seem, inconvenient or defective in practice. They require of course the greatest care on the part of the instructor: he must be on the watch continually to supply, and to compel his pupils to supply, that which is wanting in the text-book. For whatever, in this respect, may be the character of the text-book, it is clearly most important for the pupil in his recitations, that he should be accustomed to a very full development. He should not be allowed to skim lightly and sketchily over his work. He should be taught to notice and examine every point which is really essential to the conclusiveness of his reasoning. He should be guarded against the common habit of taking for granted without further proof, that which appears plausible or probable upon its face. The great advantages, which are expected from the elementary study of mathematics, as a means of mental discipline,—the clearness of thought, correctness of reasoning and precision of statements, which are supposed to be imparted by mathematical study,—are liable to be more or less completely sacrificed, unless the student is trained in the outset of his course to thorough, copious and accurate development. It is therefore a matter of no small importance that he should have a model of this quality constantly before him in the text-book which he studies. And in this particular, it is not too much to say, that the author of this Algebra is the Euclid of his department.

The practical superiority of this work, as a text-book for elementary instruction, is abundantly evinced by its long continued popularity. Many excellent treatises have appeared since this was published: yet it has not lost its hold upon the public favor. Many teachers have been sensible of the deficiencies which this revision was intended to supply: and yet have felt that these were more than balanced by superior and indispensable advantages.

It only remains to add a word on the typographical execution of the book. The press has been corrected with unusual care: and though absolute faultlessness is a thing not to be expected, it is believed that very few errors have escaped unnoticed. The style of printing has been altered in some respects; and the general appearance of the book is highly elegant and attractive.

3. *New York Journal of Pharmacy*, vol. i, Nos. 1, 2, 3, for January, February and March, 1852.—This Journal is published by authority of the College of Pharmacy of the city of New York, and is edited by Benjamin W. McCready, M.D., Professor of Materia Medica and Pharmacy in the College of Pharmacy, assisted by a publishing committee consisting of John H. Currie, Thomas B. Merrick, Eugene Dupuy, C. B. Guthrie, and George D. Coggeshall. The College of Pharmacy of New York was founded, as the address of the editor states, with a view to the elevation of the professional standing and scientific attainments of apothecaries, as well as to guard their material interests, by raising a barrier against ignorance and imposture. The establish-

ment of a Journal is to promote the same important object, besides contributing to the increase and diffusion of knowledge in this department, and exciting a spirit of inquiry and emulation in the profession. This Journal is issued monthly in numbers of 32 pages. It is stated, however, that it is no intention of the College to derive an income from the Journal; and that as soon as the state of the subscription list warrants it, it is intended to increase its size so that each number shall contain 48 instead of 32 pages. Terms three dollars per annum.

4. *Contributions to the Natural History of the Fresh Water Fishes of North America;* by CHARLES GIRARD. I. A Monograph of the Cottoids. 80 pp. 4to, with 3 plates in lithography. Smithsonian Contributions to Knowledge, vol. iii, Art. 3.—A list of the genera and species proposed as new in this memoir is given in our Appendix to this volume. The author first enters into a historical account of our knowledge of the Cottoids and of the synonymy of the species; and then mentions the geological history of the family, under the rather singular title of "the Genealogy of the Cottoids." He also briefly treats of the geographical distribution and habits of the species. The descriptions of the Cottoids of America are drawn out with fullness, and they are well illustrated in the plates. The last plate contains figures of details of structure.

5. *Elements of Electro-Metallurgy;* by ALFRED SMEE, F.R.S., 1st Amer. from 3d London edit. Revised, corrected and considerably enlarged, 364 pp. 12mo, illustrated with stereotypes and numerous woodcuts. New York, 1852. John Wiley.—The department of Electrometallurgy is one of the sudden creations of science with the past fifteen years. From the active part which Mr. Smee has taken in the progress of this art, the public have full assurance that a treatise on the subject by him will be such as is demanded; and this we find it. The author mingles in a history of the science with an account of its processes, and also enters somewhat into its theories—the latter a branch of the subject in which he has some peculiar views. The various kinds of galvanic batteries are described, their merits discussed, and of course *Smee's* battery has a prominent place, as it well deserves. Electro-metallurgy, including its numerous details, occupies the *second* Book; electro-gilding, silver-plating, etc., the *third;* applications of the reduction of metals by galvanism, the *fourth;* the electrotype, the *fifth;* galvanic etching, the *sixth;* electro-disruptive etching, the *seventh;* voltaic blasting, the *eighth.*

6. *Grundzüge der Geognosie und Geologie für Schule und Haus, nach D. T. Ansted, Dana, Dufrenoy, Hausmann, Naumann, u. A. m. frei bearbeitet;* von Dr. GUSTAV LEONHARD. 172 pp., 12mo. Stuttgart, 1852.—The author of this geological text-book, well known by his labors in geology and mineralogy, commences his work with a chapter giving the names and mineral constitution of the rocks. General explanations follow with reference to the mode of occurrence of rocks and their subdivisions, and also a chapter on the grand divisions of the animal and vegetable kingdom, with reference to the subject of fossils. The several rock formations are then treated of in a series of chapters, and wood-cuts of characteristic fossils are added in the text. Plutonic and volcanic rocks, and the action of volcanoes occupy another

division of the work; and then follows a chapter on the general features and existing phenomena of the earth's surface.

7. *Report to the Louisiana State Medical Society on the Meteorology, Vital Statistics and Hygiene of the State of Louisiana;* by E. H. Barton, A.M., M.D., to which is added an appendix showing the Experience of Life Insurance Companies in Louisiana, &c., by H. G. Heartt. 66 pp. 8vo. New Orleans, 1851.—Dr. Barton discusses in this Report on the meteorology of New Orleans and vicinity, the rates of mortality and its causes, and in each point of view, this pamphlet contains numerous facts of importance, which we are prevented from citing at this time by our limited space.

8. A. d'Archiac and J. Haime: *Description de la Formation Nummulitique de l'Inde, précédée d'un Essai d'une Monographie des Nummulites.*—The importance of the nummulitic formations of Europe and Asia, gives great interest to a work which like this of Messrs. Archiac and Haime proposes to cover the whole ground, embracing the descriptions of species and their geological relations. M. d'Archiac is the eminent author of the "Histoire des Progrès de la Geologie," a most elaborate work that should be in the hands of every geologist, and M. J. Haime has been associated with Milne Edwards in several works on Coral Zoophytes. Their high reputation for thoroughness and accuracy will commend the work to the geologists of this country. The names of subscribers are solicited by the publishers, MM. Gide and Baudry, Paris.

9. S. P. Woodward: *A Manual of the Mollusca or a Rudimentary Treatise of Recent and Fossil Shells.* 158 pp. 12mo, with wood-cuts in the text, and 12 steel plates.—An elegant plate of the Pearly Nautilus, from Owen, forms a frontispiece to this excellent manual. The subject of Mollusca is treated as a department of Zoology, the animals their structure, habits, and relations, as well as their shells being described with system and simplicity. After sixty pages on these topics, the work proceeds to a description of the genera and more prominent species. The figures of species are thickly crowded on the 12 plates, and are well made.

10. *Dannemora Jernmalmsfält i Upsala Län till dess geognostika beskaffenhet skildradt ett Försök af* A. Erdmann. Aftryck ur K. Vet. Ukad. Handl. för Ar. 1850. 138 pp. 12mo, with 16 plates. Stockholm, 1851.—The iron mines of Dannemora are so famous as to give great interest to an account of them, especially by one so able as M. Erdmann. The author describes with care the geology of the region, and gives analyses of some minerals, with also mining statistics. Besides the usual superficial survey, he enters very fully into an account of the changes found in the veins or beds, at different depths of descent. These changes are illustrated in the plates, the form of the bed or masses of iron ore being shown by colors, and the successive plates exhibiting the variations of size and shape in these beds or masses. It is curious to observe the enlargement or coalescence of certain of the isolated beds, in the descent, and the disappearance or total change of character in others. Such plates show the nature of the whole mass and not merely its surface outline. Dannemora is situated near the small lake Dannemora, 18 to 20 miles north of Upsala. The prevailing rock of the region is the feldspathic rock called

Helleflinta, but gneiss occurs near by on the east and west, and not far distant, granite. There are some patches of granular limestone, and with these the iron beds are connected, the limestone being the usual gangue.

11. *Report on Meteorology;* by JAMES P. ESPY. 65 pp. folio, with numerous charts.—This Report of Prof. Espy on Meteorology commences with a list of the many observers whose results have been collated in its preparation. In the following pages, Prof. Espy presents a review of the principles which he considers as established by the observations, and under the title of "Directions for Mariners, etc." many important facts, discussions and propositions are included. As we have no space at present for a discussion of these topics, we do not cite from them in this place. Various directions with regard to methods of observing, and an enumeration of points of special interest, are also embraced in this part of the volume. The plates present to the eye, a summary of the observations upon winds of different periods and places, exhibiting their changes in storms during successive days, and marking the strength as well as direction of the wind, the amount of rain, and to some extent, the barometric pressure and temperature. There is therefore much information condensed into a single chart. Such maps carefully prepared are the best means of bringing out meteorological results for general apprehension. We however observe that the work lacks the facts (that is, the meteorological tables) from which the maps are constructed, and we have no information also as to the special character and accuracy of the instruments with which the observations were made. It is to be hoped that in future Reports, both full tables and detailed particulars may be given. If but one portion is to be published, the maps, or the tables, the latter should have the preference, as of far higher value to meteorological science. The voluminous Russian meteorological Reports under government authority, are excellent models in this respect.

12. *Michaux's North American Sylva, with three Supplementary volumes;* by T. NUTTALL. R. P. Smith, Philadelphia, Publisher.—The three volumes by Nuttall contain 121 colored plates, and add greatly to the value of the original magnificent work by Michaux. We would direct attention to the advertisement of this work in our advertising sheet, and also to that of Carson's Illustrations of Medical Botany.

13. *A Synopsis of the Family Naiades;* by ISAAC LEA.—A new edition (the third) of this work has been put to press by the author. It will be in 4to, like the last, and double the size.

D. A. WELLS: The Annual of Scientific Discovery, for the year 1851. *Boston,* 1852.

WM. HENRY HARVEY: Nereis Boreali-Americana, or Contributions to a History of the Marine Algæ of North America. Part I, Melanospermeæ. Smithsonian Institution. *New York,* 1852. G. P. Putnam. A notice of this work will appear in our next number.

PROCEEDINGS OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, vol. vi, No. 1.—p. 1. Death of fish in the bay of Callao from the escape of sulphuretted hydrogen from its bottom; *J. L. Burtt.*—*Rhinoceros americanus,* a new species; *J. Leidy.* —Notes on some Fossil Suiline Pachyderms from Illinois, (Hyops depressifrons now called by the author *Dicotyles depressifrons,* and *Protochœrus prismaticus*); by *J. L. LeConte.*—p. 5. Notice of a fossil Dicotyles (D. costatus) from Missouri; *J. L. Le*

Conte.—p. 6. Conspectus of the Crustacea of the Exploring Expedition under Capt. Wilkes, U.S.N., including new species and genera of Paguri and of Megalopidea, and a synopsis of the genera of Macroura with new genera and species; *James D. Dana.*—p. 30. On certain characteristics of the Troglodytes Gorilla of Gaboon River; *H. A. Ford.*—p. 34. Emys Culbertsoni, a new fossil turtle from Nebraska Terr.; *J. Leidy.*—p. 35. Delphinus Conradi from the Miocene of Va., Thoracosaurus grandis, from the Greensand formation of New Jersey; *J. Leidy.*—p. 35. On the difference between Primordial races and Introduced races; *J. L. LeConte.*—p. 36. Hints towards a natural classification of the family Histrini of Coleopterous Insects; *J. L. LeConte.*—p. 41. Synopsis of the Parnidæ of the United States; *J. L. LeConte.*—p. 45. Synopsis of the Eucnemides of Temperate North America; *J. L. LeConte.*—p. 49. On the Impregnation of the Eggs of the Queen Bee; *L. L. Langstroth.*—Plates 10 and 11, representing Vireo Huttoni, Vireosylvia philadelphica and Vireosylvia flavoviridis, illustrate vol. v, pages 150 to 153.

PROCEEDINGS OF THE BOSTON SOCIETY OF NATURAL HISTORY.—FEBRUARY, 1852.—p. 129. On a Mastodon tooth from near Baltimore; *Dr. Warner.*—p. 131. On fossil rain-drops; *Desor, C. T. Jackson.*—p. 133. A new species of Ophiolepis (O. tenuis), and remarks on other American species; *Ayres.*—p. 137. Description of a new Planaria and a new Nemertes from the Coast of Florida (Thysanozoon nigrum and Meckelia atra); *C. Girard.*—p. 137. On the geographical range of certain North American Reptiles; *H. R. Storer.*—p. 138. Descriptions of five new species of Fossil Fish and on the fossil plants of the Albert Coal Mine from near New Brunswick; *C. T. Jackson.*—p. 143. Description of the *Chirodota arenata*, Gould; *Ayres.*—MARCH. p. 146. Notes on the Reptilia of Aiken, Georgia; *W. I. Burnett.*—*Heterodon niger* found in Connecticut; *Ayres.*—*Cistudo Blandingii*, found in Massachusetts; *Storer.*—*Salamandra symmetrica*, found in Canada.—p. 147. Notes on the Holothuridæ of the United States; *Ayres.*—p. 149. Notes on the brain and spinal chord of the *Lophius americanus; J. Wyman.*—p. 152. On a specimen of Stigmaria in Anthracite; *J. E. Teschemacher.*—p. 155. Descriptions of new species of Cyclas; *Prime.*

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L.

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V.

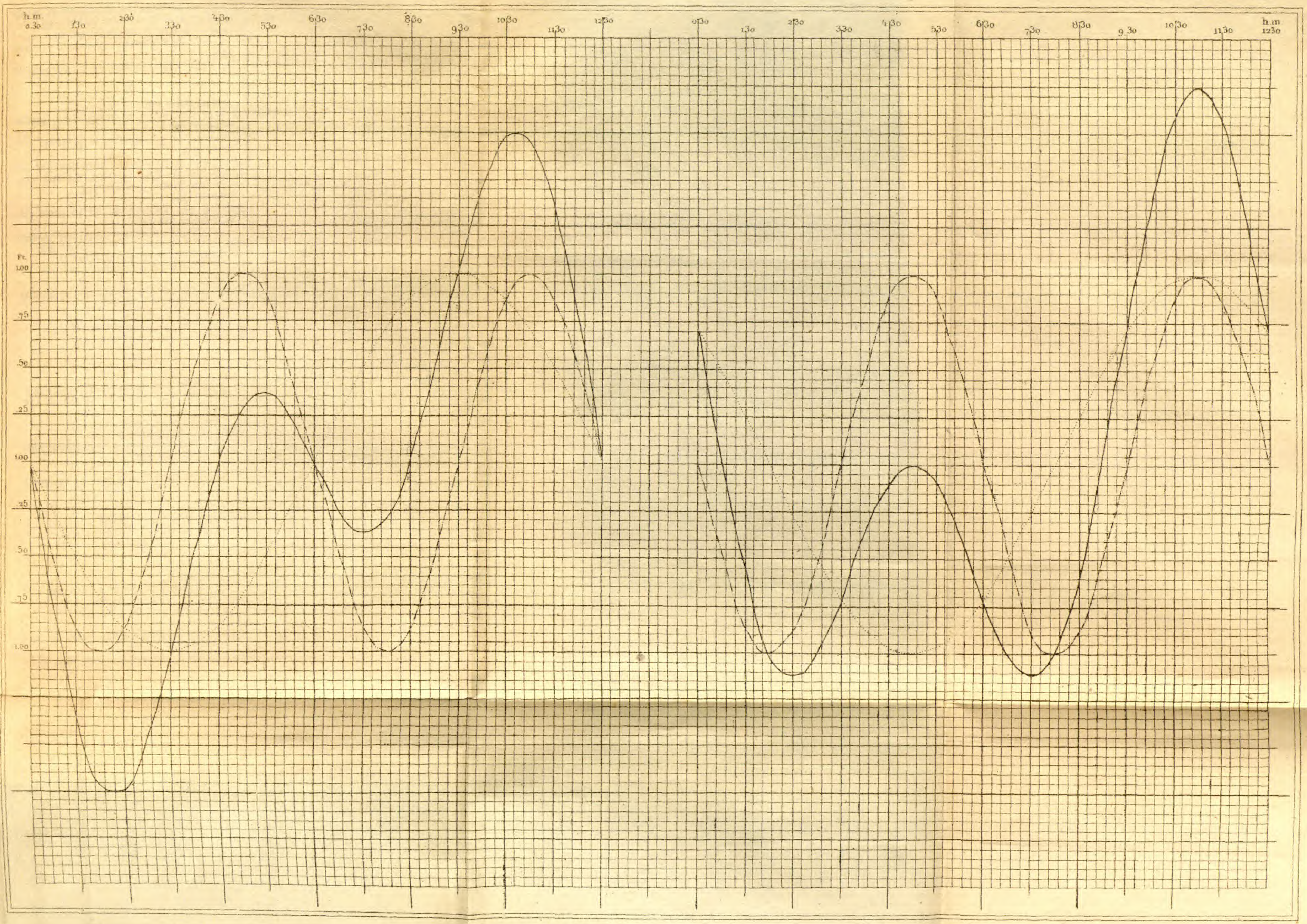
W.

Z.

Plate No. 5

Showing Change of compound curve with Change of E.

No. 1. E = 9 hours, S = D — *No. 2. E = 12 hours, S = D*

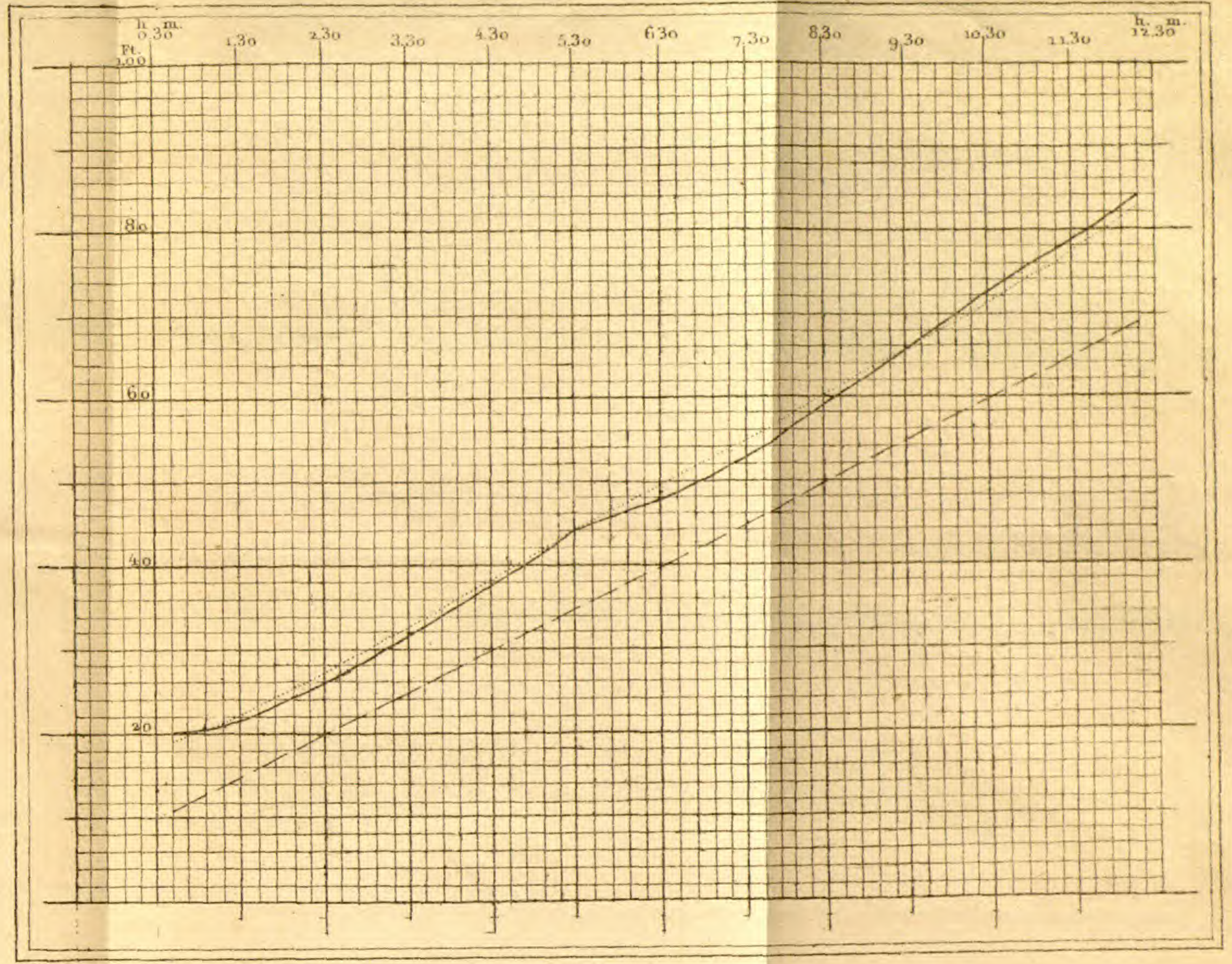


Semi-Diurnal Curve (S)
Diurnal Curve (D)
Compound Curve

No. 2

Whole year 1851-2

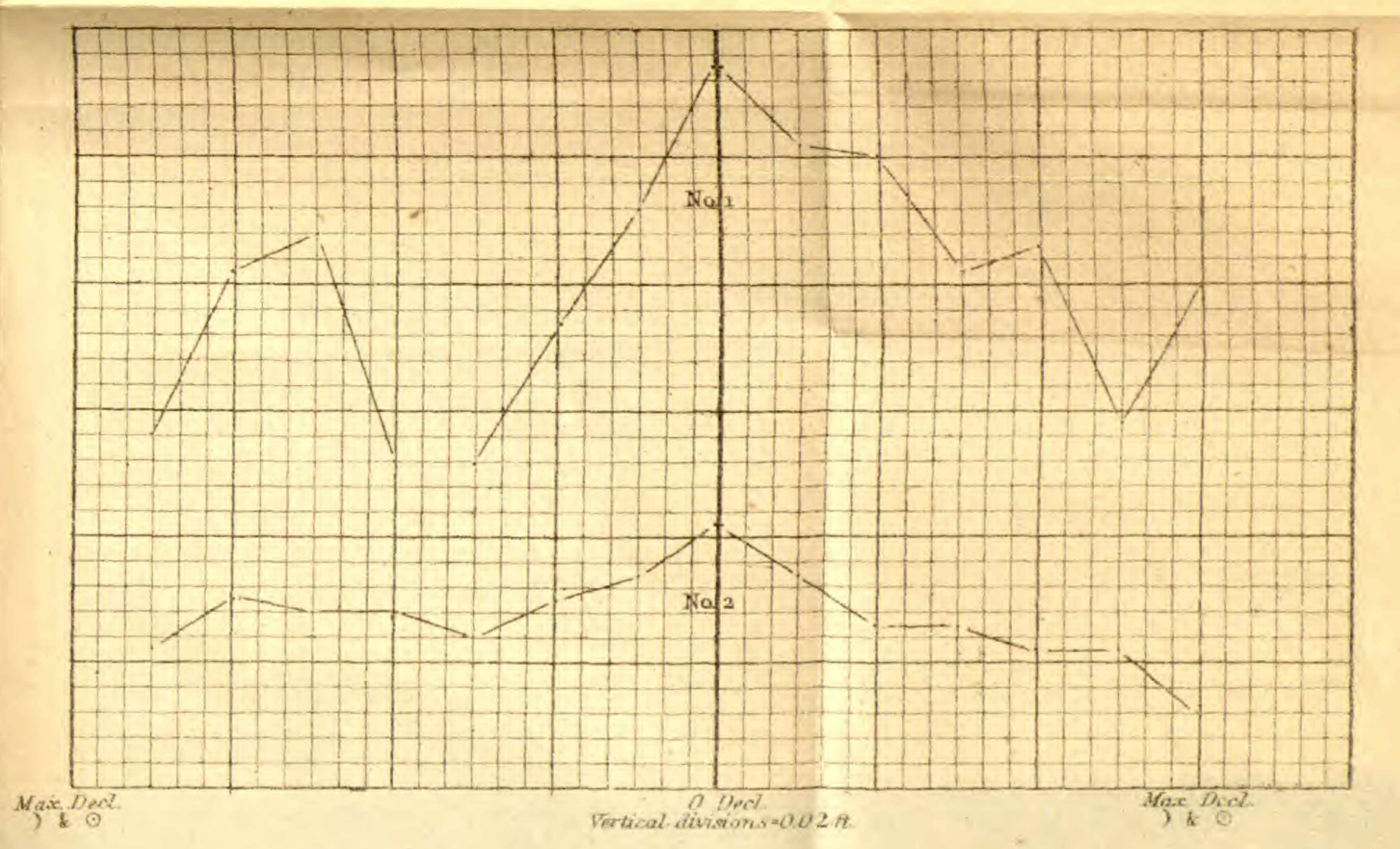
Plate No. 3 *Comparison of Diurnal Inequality from observation and discussion of Curves with Moon's Decl.*



Observation
Discussion
Sine of Twice Moon's Decl.

Plate No. 6

Showing the mean level of the water at Key West the observations arranged according to the declination of the Moon (No. 1) & the Sun (No. 2) respectively



No. 28

Plate No. 2. *Comparison of half monthly inequality in interval and height from theory and observation — Whole year*

——————— *Theory*
– – – – – – – *Observation*

No. 1 Interval *No. 2 Height*

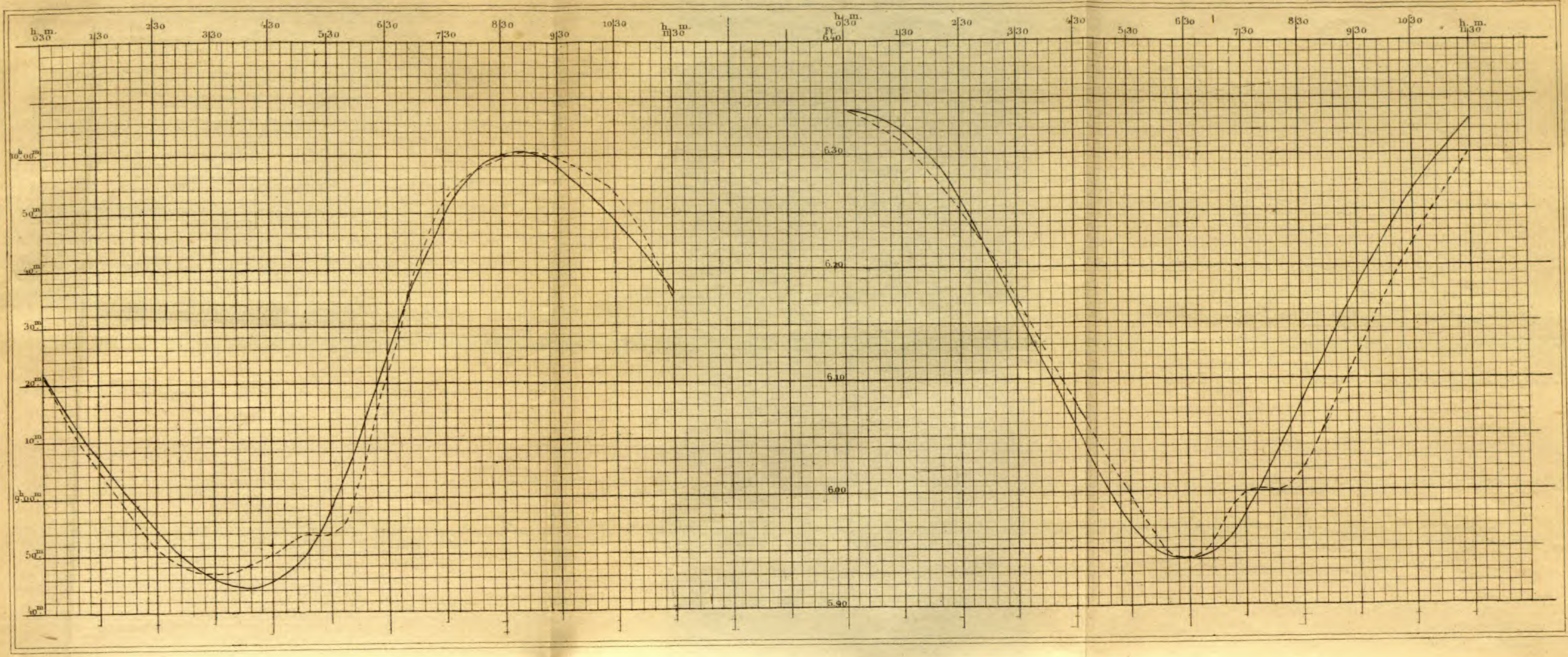


Plate No. 4

Comparison of halfmonthly inequality in Interval and Height from theory & observation — Semi-diurnal wave

– – – – – – – *Observation*
——————— *Theory*

No. 1 Interval *No. 2 Height*

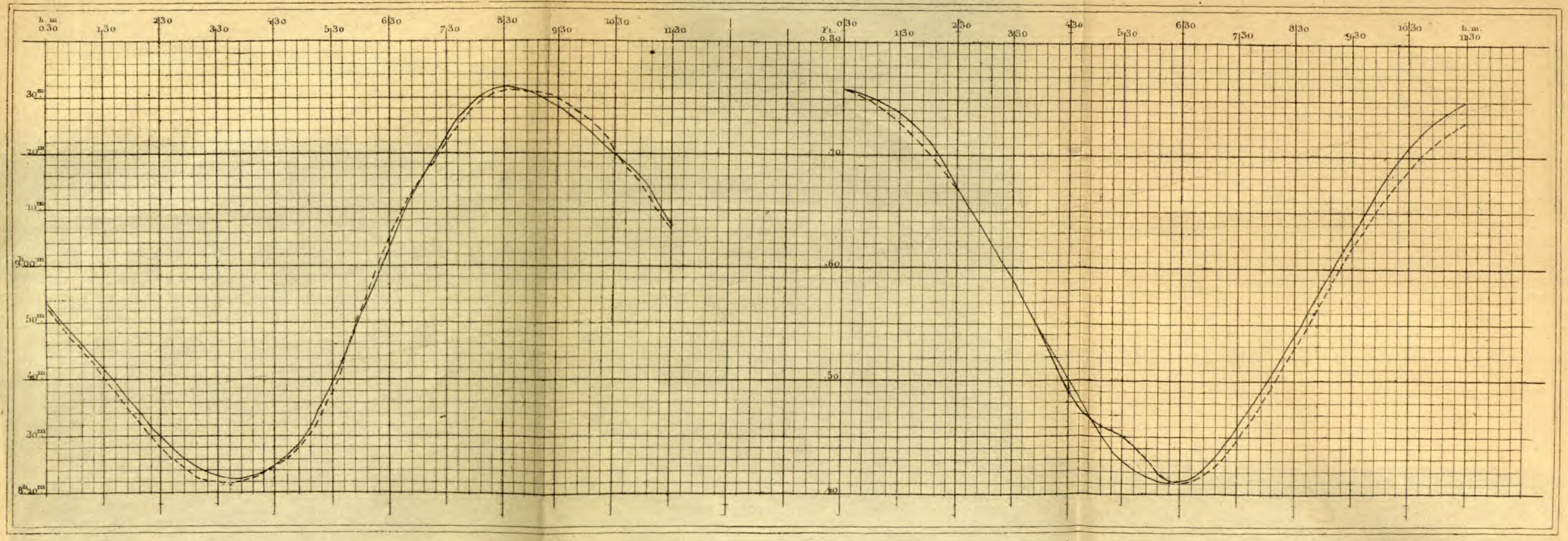


Plate No. 1

Type Curves, Key West, Max. Decl. of Moon

Semi-Diurnal Curve (S)
Diurnal Curve (D)
Compound Curve

No. 1 Maximum S. (Syzygies)

No. 2 Minimum S. (Quadratures)

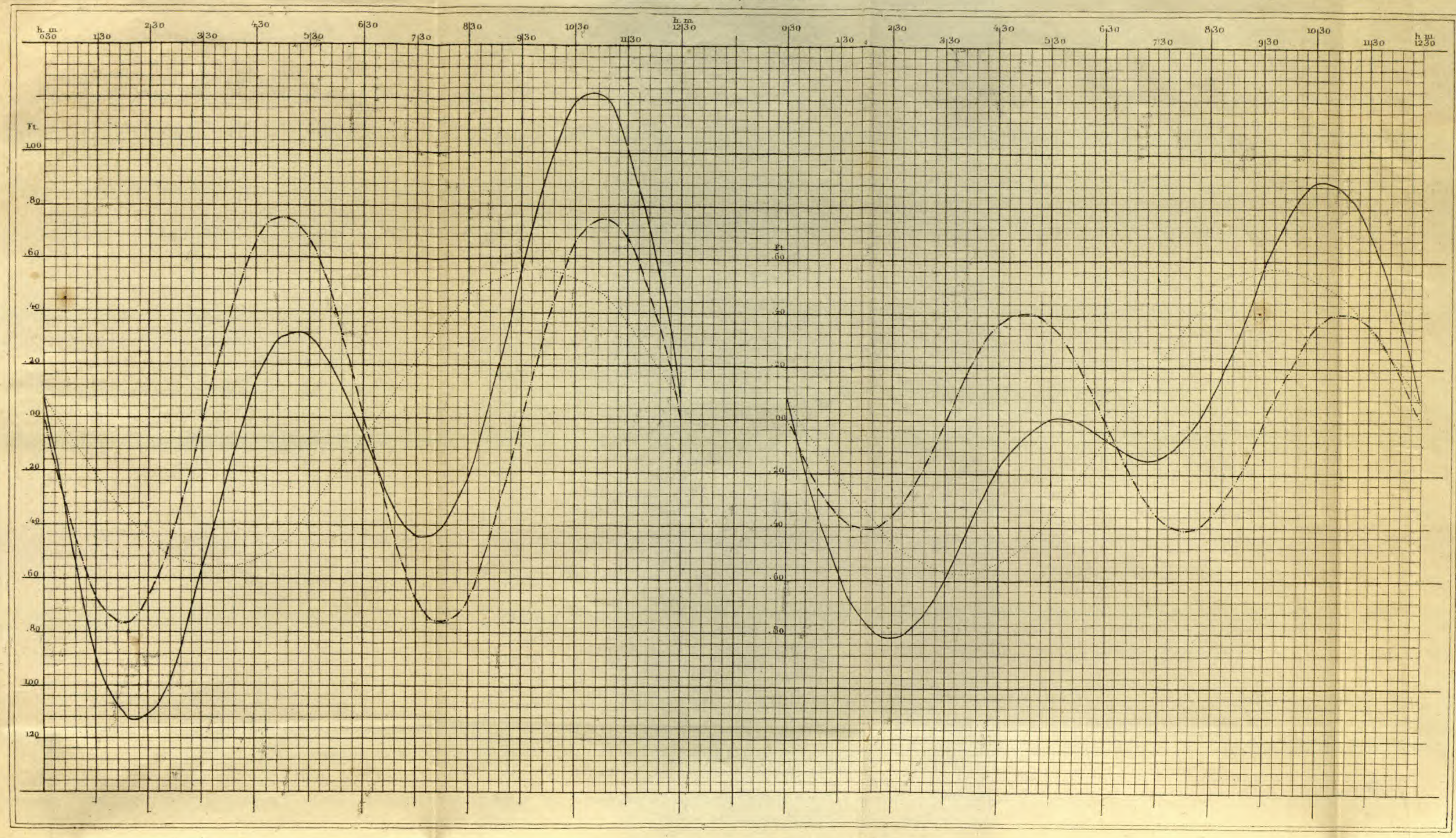
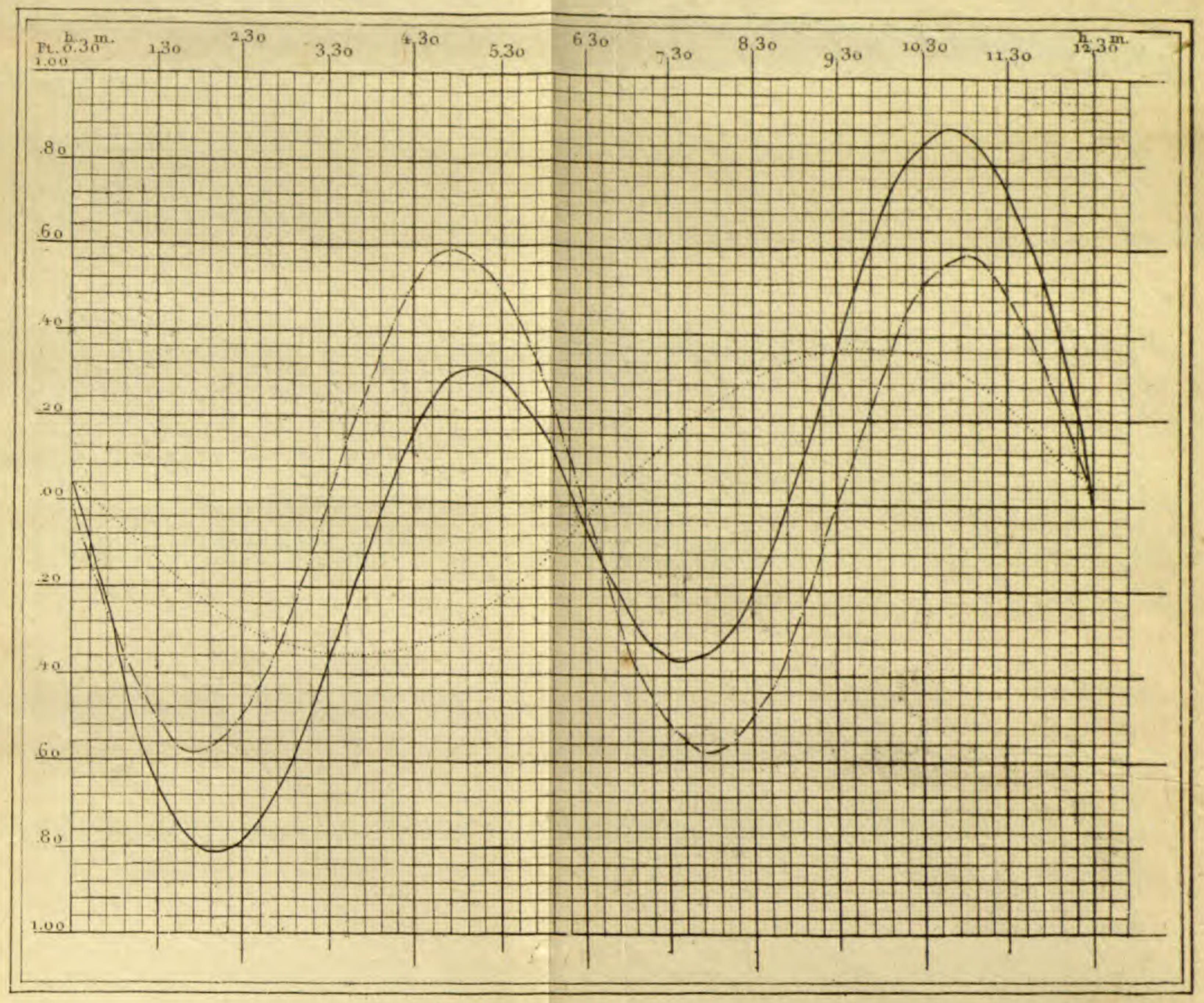


Plate 1 *(tris)*

Type Curves, Key West, Mean Decl. of Moon

No. 5 *Mean S.* *Mean D.*



Semi-Diurnal Curve (S)
Diurnal Curve (D)
Compound Curve

Plate No. 1 (bis)

Type Curves Key West. Zero Decl. of Moon

Semi-Diurnal Curve (S)
Diurnal Curve (D)
Compound Curve

No. 3. Maximum S. (Syzygies)

No. 4. Minimum S. (Quadratures)