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OF

SCIENCE AND ARTS.

CONDUCTED BY

PROFESSORS B. SILLIMAN, B. SILLIMAN, JR.,
AND
JAMES D. DANA.
AIDED BY
DR. WOLCOTT GIBBS, OF NEW YORK,
IN PHYSICS AND CHEMISTRY,
AND
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WITH A MAP AND TWO PLATES.

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ERRATA.

P. 162, first line, for "130," read "189."
P. 278, line 9 from top, for "113°," read "130°."
P. 279, " 9 from top, for "Fe," read "Fl."
P. 325, line 11 from top, for "*northeastern*," read "*northwestern*."
P. 358, line 11 from bottom, for "And in another *place*," read "And in another *work*."
P. 358, line 18 from bottom, for "In one of his *desultory volumes*," read "*In his Music of Nature*."
P. 433, line 4 from top, for "*Sunadin*," read "*Sanidin*."
In part of edition, P. 440, 4th line from bottom, for "*ibid*," read "J. f. pr. Ch., lvii, 276."
Vol. xiv, p. 62, line 20 from bottom, for "M : T," read "M or T."

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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. I.—*Notice of Meteoric Iron near Lion River, Great Namaqualand, South Africa; and of the detection of Potassium in Meteoric Iron:* by Charles Upham Shepard, M.D.

1. The meteoric mass now described, was brought from the Cape of Good Hope to London in July, by Mr. Gill, for Mr. John Gibbs; with instructions to dispose of it there on his account. Prof. J. Tennant, mineralogist to her majesty, having become the purchaser, transferred it to me in a very obliging manner; and it is now deposited in my meteoric collection in Amherst College.

Its weight is 178 lbs. Mr. Gibbs describes it as having been found on a clay plain near Lion river, in the close vicinity of one or more masses, "too heavy for transport;" the removal of the present lump to the Cape by wagon, a distance of nearly 800 miles over the worst possible roads, being spoken of, as attended with no small inconvenience. It having been very securely packed in a box, its surface has been preserved from injury in the most perfect manner; and with the exception of two slight gashes, (apparently made by a saw,) and the abstraction of a slight projection from the larger end, it is as entire as a casting, fresh from its mould. Mr. Gibbs remarks in his note, "the part cut has been done by the Namaquas for fabricating arrow-heads and assagais; the traces of two or three abortive attempts of cutting may also be seen on the surface of the mass."

The box contained several fragments of the clay, spoken of as forming the plain on which the mass was found. This clay is a compact and hard marl, penetrated by seams of iron-pyrites, which appear to fill spaces once occupied by fossil shells. It may be presumed therefore, that it belongs to the tertiary series in geology; and inasmuch as the iron-mass presents a perfectly clean, and nearly an unoxydated surface, it is possible that its fall has either been very recent, or that it has until lately been imbedded in this formation, and thus preserved from rusting. On the latter supposition, its descent will date back to the geological period of the tertiary.

It is certainly remarkable in the history of these bodies, that their external figure has so often resembled the heads of various animals. The present mass, as figure 1 will show, is another instance of the same fact. It resembles the head of the horse, not only in shape but also in size. Nor is the similarity confined to a single position, but exists whether the mass is viewed on either side, as well as from above, or below; inasmuch as it possesses a wonderful degree of bi-lateral symmetry, having the depressions to a certain extent, repeated on both its sides when in the position of the figure. And what is remarkable also, these concavities are disposed in parallel rows or curves. A curvature upwards is likewise present, thus imparting a slight convexity to the top, and a corresponding concavity to the base. It measures 19½ inches in length, 12 in depth, and 13½ in breadth.

The depressions are every where shallow; and their borders, where they are contiguous to each other, or where they connect with the general surfaces, are softly rounded off; so that there is not a sharp angle or edge upon the mass. Gentle curves and flowing outlines every where prevail, throughout the mass. It can scarcely be said to possess any crust whatever. Its color is blackish iron-gray, mixed with patches of an ochrey brown, through which, a submetallic lustre is rarely visible.

On being struck with a cane, or the handle of a common hammer, a peculiar ringing sound is produced, a circumstance which I have noticed on some other considerable lumps of meteoric iron.

Having sawn a fragment of 120 grains from a projecting ridge, at the larger end, where the natives had chiseled off the piece above referred to, it became apparent that this iron was soft, homogeneous, closely crystalline and perfectly compact. It gave a Gr. = 7·45. When polished and etched, it gave triangular delineations, intermingled with slightly curved, parallel lines; the latter no doubt occasioned by a disturbance of the original structure, in the process of chiseling. The more interior surface, connected with the main mass, was, when etched, destitute of these curved lines, and presented on the whole, a very close resemblance to the Widmannstättian figures of the Lenarto and the Elbogen irons.

This iron does not exhibit the passivity observed by Wöhler in the Green county, Tenn. meteorite and some others; but on the contrary, promptly precipitates copper from a solution of the sulphate of this metal.

1.

It dissolves pretty rapidly in hydrochloric acid, with escape of hydrogen, having nearly the same odor as that evolved from pure iron; but a paper moistened with acetate of lead, acquired a feeble browning, on being held for some time in the current of the gas. It dissolved without any remainder whatever, in nitro-hydrochloric acid.

The solution in hydrochloric acid was treated for some time with a current of sulphuretted hydrogen. The next day, a feeble cloudiness, of a yellowish brown color appeared in the liquid. It was transferred to a filter; and what remained upon it, after a thorough washing, was treated with strong nitric acid. A heavy powder was formed, and the clear liquid gave no blue color on the addition of ammonia. The powder was heated with carbonate of soda on charcoal before the blowpipe, and the charcoal crushed in a mortar. It gave globules which resembled tin. Twenty-five grs. of the iron were dissolved in nitro-hydrochloric acid, and precipitated by excess of ammonia. A deep blue liquid was obtained on filtration. This was brought to the boiling point, and precipitated by excess of potassa. The green hydrated oxyd of nickel, after being well washed and ignited, weighed 2·04 grs., which equals 1·65 grs. of metallic nickel. It was tested for cobalt before the blowpipe, without affording any indication of its presence.

The peroxyd of iron was ignited for half an hour in a platinum crucible, with its weight of carbonate of soda. Water was boiled upon the fused mass, and after filtration and neutralization with nitric acid, the clear liquid was treated with solutions of hydrochlorate of ammonia and of sulphate of magnesia. An immediate precipitate of the phosphate of ammonia and magnesia was produced, proving that the peroxyd of iron had contained phosphoric acid.

Having observed that the polished face on the mass gathered rust freely, in one spot, though kept in a situation quite free from moisture, I was led to apply a piece of moistened turmeric paper to the oxydated region, when it immediately gave an alkaline reaction. That this effect is not wholly ascribable to ammonia will I think appear from an experiment described at the end of this notice, upon meteoric iron from another locality.

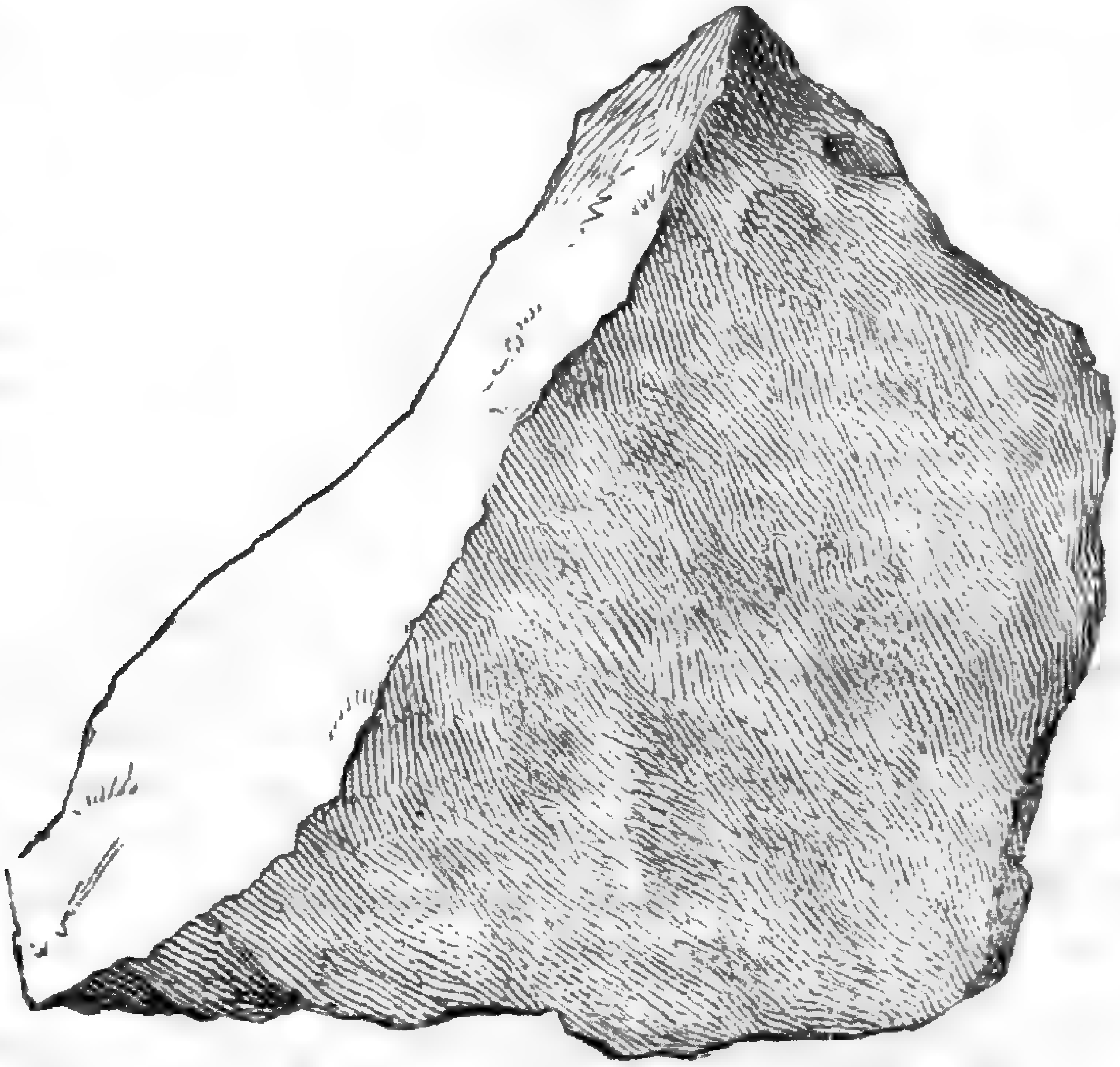
The following therefore is a summary of the results obtained on a single analysis of the Lion river meteoric iron:

Nickel, - - - -	6·70
Iron, with traces of Phosphorus, Sulphur, Tin, and Potassium? - -	93·30
	100·00

2. *Potassium in the Meteoric Iron of Ruff's Mountain, South Carolina.*—This iron, it should here be mentioned, was not found on that part of the mountain situated in Newberry, as formerly supposed; but in the contiguous county of Lexington.

Having noticed a peculiarity in the manner in which this iron acquires rust, even when kept in a dry air, I suspected that it proceeded, in part, from the oxydation of potassium. The broad flat face of the 55 lbs. mass* figured below, rusts upon one margin to the depth of nearly two inches; and at times obviously gathers moisture, while the rest of the surface retains its dryness and polish. Turmeric paper applied to the moistened spots were immediately browned. This led me to subject two ounces of the rusted turnings of the iron, obtained in making sections of the mass, to a heat of near redness in a double crucible, for half an hour, and to test the water boiled upon it with reddened litmus and turmeric. It gave an alkaline reaction in both instances, which under the circumstances sufficiently proves that a fixed alkali was present. The deliquescence observed renders it probable, that it was owing to the carbonate of potassa, rather than to the carbonate of soda, although there is nothing to disprove the presence of the latter alkali also.

2.



The condition in which potassium is present is of course only conjectural. It probably exists as an alloy with some of the other metals, which is not uniformly distributed throughout the

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* The mass measures 8¼ inches in height, and 7½ inches horizontally across the polished face.

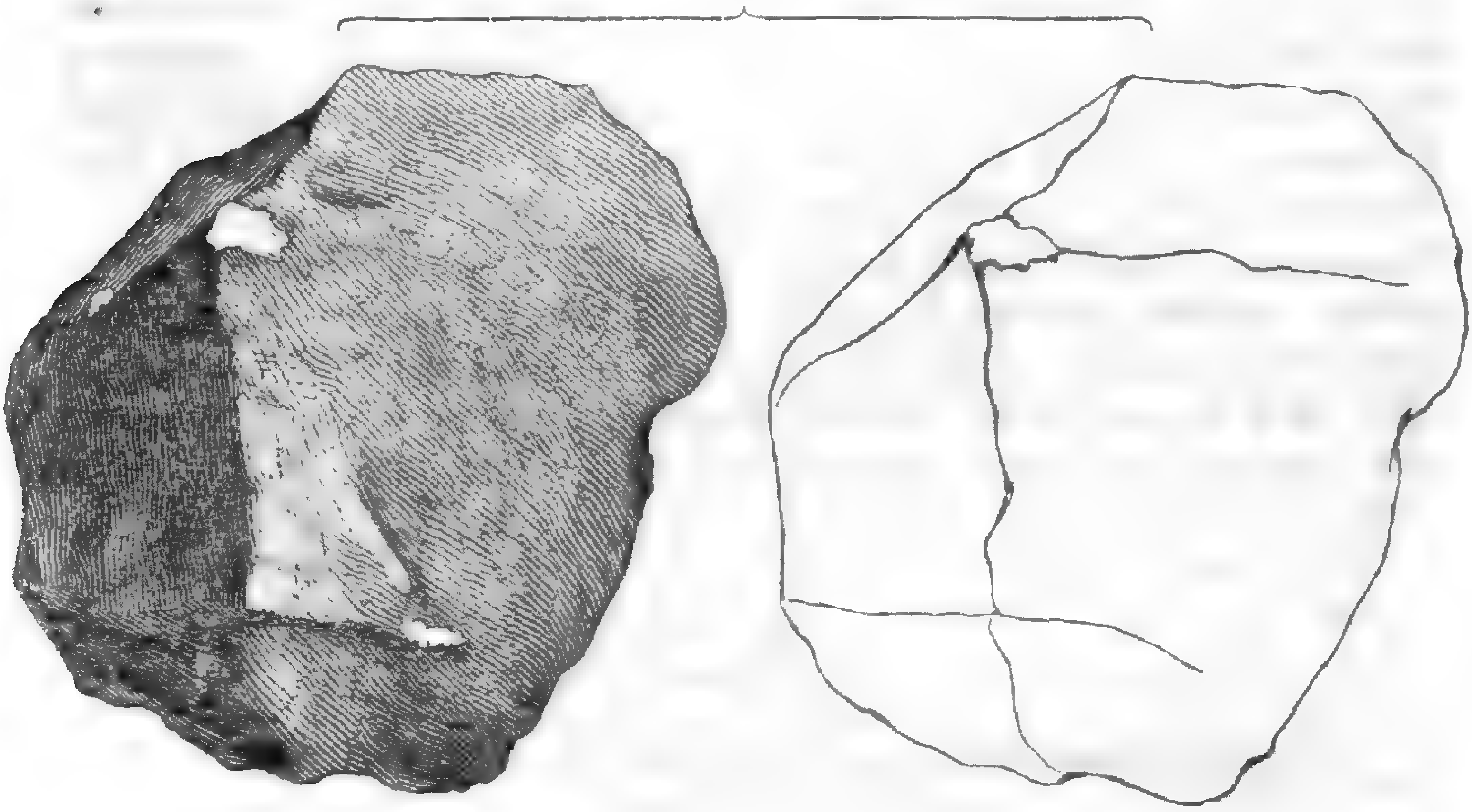
mass. Indeed the artisan who superintended the division of the iron, informed me that he detected a marked difference in the softness and malleability of the metal in particular portions of the mass.

It may also be mentioned, as indicative of the occasional, localized occurrence, of unusual elements in meteoric irons, that in cutting a slice from the very compact Burlington, N. Y. iron, a single, very symmetrical, drop-shaped cavity more than half an inch in diameter was disclosed, which communicated by a minute opening with the surface. Its walls are almost perfectly smooth, and coated by a brownish black powder, not yet examined. The Lenarto iron, also a compact one, contained three empty cavities; and a third iron of the same character, that from Murfreesboro', Rutherford Co., Tenn., had two small cavities, the one two-tenths and the other one-tenth of an inch in diameter. Is it probable that these cavities were originally empty? or if not, with what bodies were they occupied?

If meteorites are, as Baron Reichenbach supposes, miniature representatives of the larger planetary bodies, differing from them only in magnitudes, the chemical constitution now made out for the former, may perhaps be thought to have a bearing upon the views, put forth by Sir Humphrey Davy, in his explanations of volcanoes, relative to the condition of the elements in the interior of our earth, where, as he suggests they may still exist to a large extent, in an unoxydated state. We may at the present moment perhaps be said to have found the following metals in our meteorites in an unoxydated (and in an unchloridized) condition: viz, Fe, Mn, Ni, Co, Sn, Cr, Co, Ar, K, Na, Ca, Mg, Al, Si, P, S, C. Farther researches will doubtless, soon augment the number.

3. *Figure of the Iowa Meteoric Stone, which was seen to fall Feb.* 25, 1847.—This stone was particularly described by me

3.



in my report on meteorites published in vol. vi, new series, of the Amer. Journal of Science and Arts, p. 404. The drawings in fig. 3 (as well as those of the two preceding ones) were made by Mr. R. Bakewell. The uncommon completeness and perfection of form in this stone, seemed to render it worthy of being accurately figured. Its greatest diameter is four inches: from the fractured apex of the four-sided pyramid to the centre of the opposite side, measures 3½ inches. It weighs 2 lbs. 8⅛ oz.

Art. II.—*Notice of Professor Clark's Thesis on Metallic Meteorites.**

Prof. Wm. S. Clark of the Scientific Department in Amherst College has presented a valuable contribution to the science of Astrolithology, in an Inaugural Dissertation on his promotion to the rank of Doctor of Philosophy at the University of Göttingen. The following extracts from the dissertation, are intended to give a general view of such facts and observations as are either new, or at least have not been presented in the pages of this Journal.

The color of meteoric metal varies from silver-white to dull gray, and the hardness from that of the hardest steel to that of metallic copper. The specific gravity is usually between 7 and 8, though rarely as low as 6. It varies exceedingly on different parts of the same mass. The metal is generally very malleable, both hot and cold; and of course difficultly fusible. Wöhler has observed that the metal of some meteorites is in a passive, and that of others in an active condition; so that specimens of some precipitate copper from a solution of the sulphate, while those of others, do not. He infers from his experiments, that all meteoric metal is probably passive at the time of its fall, and becomes active after long exposure on the earth. Besides the chrysolite found in the masses of Krasnojarsk, Atacama, etc.; almost microscopic grains of a mineral harder than glass and resembling the finest quartz sand, are often to be seen in the insoluble residue obtained by digesting pieces of meteoric metal in hydrochloric acid. Stromeyer made a series of experiments upon chrysolite of terrestrial and of meteoric origin; and came to the astonishing conclusion, that the former usually contains nickel, while the latter though imbedded in nickeliferous iron, contains none.

Rumler first discovered arsenic to belong to the meteoric elements, while testing the Atacama chrysolite for water. When meteoric metal is dissolved in an acid, the solution almost inva-

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* Eighty pages 8vo, with 3 lithographic plates. Printed by W. F. Kaestner; Dieterich's University Press.

riably contains phosphoric acid, formed by the oxydation of the phosphurets. It seems indeed, as if phosphorus were as characteristic an ingredient of meteoric masses as nickel; and it is a singular fact, as Wöhler has remarked, that there are no mineral phosphurets of terrestrial origin. The meteoric phosphurets are nearly insoluble in hydrochloric acid; and constitute from 0·5 to 2·5 p. c. of most metallic masses. They form either a black, flocky residue (dyslytite of Shepard); thin, elastic, bronze-yellow plates (schreibersite of Patera); or brilliant four-sided prismatic crystals. They consist of iron, nickel and phosphorus, with perhaps, occasionally, carbon and magnesium.

Prof. Clark observes that he aims to give in his thesis a concise yet complete history of the characteristics and literature of every metallic mass of undoubted meteoric origin, observiug that his best thanks are due to his highly honored instructor, Prof. Wöhler, for his kindness in furnishing him with specimens for analysis, and in allowing him free access to his library and cabinet. The classification adopted is to describe first, those containing chrysolite, secondly, such as inclose large quantities of pyrites, thirdly, those rich in nickel, and finally, such as are composed of nearly pure iron.

1. *Krasnojarsk.* According to Rumler, the chrysolite of this and of all Atacama iron contains arsenic.—2. *Atacama.* The chrysolite forms, in bulk, about half the mass. Acids scarcely attack that part of the metal next to the chrysolite, which consequently retains its lustre, while the central portions of the angular masses, when acted on by acids, become dull gray, the whole presenting to view dark areas surrounded by a bright border, which separates them from the chrysolite. These dark areas are often intersected by brilliant lines.—3. ***Potosi***, Bolivia, S. A. Partsch believes it to be from Atacama. According to Morren the metallic part consists of iron 90·241 and nickel 9·759. The mass is now in the museum at Angers, France.—4. ***Steinbach***, Saxony. The mass was found preserved in the cabinet of von Schönberg of Gotha, with this label, "a curious piece of native iron so discovered in the field." The color of the metal inclines more to gray than that of the masses of Atacama and Siberia. The olivenoid mineral is brownish green, granular, somewhat cleavable, and according to Stromeyer is a tersilicate of magnesia, while the chrysolite of other meteorites is a simple silicate.—5. *Fort Singhur*, near Pouna in the Deccan, India. Described by Giraud in 1849. This mass had the form of an irregular 3-sided prism with conical terminations, and weighed 31¼ lbs. It was found upon a basaltic mountain 4500 feet above the sea. It is exceedingly vesicular, the cavities being filled with an olivenoid substance of a yellowish white color, in opaque, earthy massess of the size of a pea. The metallic portion contains several per cent. of nickel. Sp. gr. =4·72—4·90, Giraud.

—6. *Brahin*, Russia. Discovered in 1810. Two masses, weighing together 200 lbs., now at the cabinet of University at Kiew. The chrysolite forms more than half the mass. Analysis by Laugier,

Iron,	87·35
Nickel,	2·50
Chromium,	0·50
Magnesium,	2·10
Silica,	6·30
Sulphur,	1·85
	100·60

7. *Hommoney Creek*, Buncombe Co., N. C. Prof. Clark has analyzed this somewhat peculiar iron anew, and finds

Iron,	93·225
Nickel, Cobalt,	0·236
Copper, Tin,	0·099
Manganese,	?
Silicon,	0·501
Magnesium,	?
Phosphorus,	?
Sulphur,	0·543
Graphite, Schreibersite,* (Patera,)	4·765

The metal, which is somewhat malleable, exhibits when etched on polished surfaces, in some places, a dull, gray field with a few bright points, and in others, very minute, yet distinct and beautiful, triangular figures. The hardness is exceedingly variable, and seems to be greatest where the figures are most readily brought to view. The analysis was made from a very hard piece about three grammes in weight. It was digested in hydrochloric acid until hydrogen gas ceased to be evolved. That which was generated possessed an exceedingly disagreeable odor, and being conducted through a solution of silver produced a slight precipitate of sulphuret. The insoluble residue retained the form of the original fragment, and consisted of brilliant scales of graphite, a black, flocky substance and a magnetic portion, which under the microscope appeared to be a network of crystalline plates, intersecting each other at angles of about 60° and 120°, exactly resembling the figures, exhibited by an etched surface of the mass at this place. The magnetic portion was fused with carbonate and nitrate of soda. The mass, which was col-

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* The name Schreibersite, here applied to the difficultly soluble compound of iron, nickel and phosphorus, refers to the substance which was previously designated dyslytite by Shepard.

ored by manganese, was then digested in water, and the colorless fluid filtered from the metallic oxyds. This was tested in the usual way with a solution of magnesia and with molybdate of ammonia, and found to contain phosphoric acid. The oxyds were dissolved in hydrochloric acid, and the iron precipitated by ammonia. The filtrate was treated with hydrosulphuret of ammonia, which threw down a black sulphuret, insoluble in dilute hydrochloric acid. The quantity was too small for nearer examination. The plates which appear to produce the figures in this meteorite are therefore in all probability, the phosphuret of iron and nickel, though present in small quantity and very unequally disseminated through the mass. A number of brownish particles, harder than glass, and resembling the granular chrysolite of the Atacama iron, were also observed in the insoluble residue. The solution filtered from the insoluble portion was saturated with sulphuretted hydrogen gas, and the light brown precipitate formed was collected on a filter, washed, roasted and weighed. It was then reduced with soda before the blowpipe, and yielded a malleable globule of a reddish white color, containing copper and tin. The sour solution, filtered from the sulphurets, was boiled to expel the excess of sulphuretted hydrogen, and the iron oxydized with chlorine gas and precipitated by means of succinate of ammonia. After weighing, the oxyd of iron was fused with carbonate of soda and found to contain phosphoric acid and silica. The filtrate from the iron was concentrated by evaporation, and treated with a slight excess of sulphuret of hydrogen and ammonia, by which a few milligrams of the sulphurets of cobalt and nickel were precipitated. After the fluid became clear and colorless, it was filtered, and the sulphurets roasted and weighed. Tested before the blowpipe, the oxyds obtained appeared to contain much more cobalt than nickel. The solution filtered from the sulphurets was evaporated to dryness, the ammoniacal salts driven off, and a small quantity of magnesia thus detected.

8. *Bitburg*, in the Eifel. Found in 1805. Described by Col. Gibbs. Weight 3300 to 3400 lbs. This enormous mass was discovered in repairing a road and was heated and hammered at an iron furnace with the exception of a few ounces. It contains a light green olivenoid substance in small quantity, irregularly scattered through its mass. Sp. gr. = 6·52, Rumler. Analyses:

	Stromeyer.	John.
Iron,	81·8	78·82
Nickel,	11·9	8·10
Cobalt,	1·0	3·00
Manganese,	0·2	
Silicon,		0·05
Silica,		5·50
Sulphur,	5·1	4·50
	100·00	99·97

9. *Rasgata*, New Grenada. Discovered in 1810. Described by Rivero and Boussingault in 1823. Weight of smaller mass 45 lbs., of larger 84 lbs. A vesicular mass containing cavities of various sizes which are partly filled with pyrites. Metal hard, but quite malleable. Sp. gr. = 7·3 – 7·7, Rumler. Analyses:

	Wöhler.	Riv. and Bous.
Iron,	92·35	90·76
Nickel,	6·71	7·87
Cobalt,	0·25	
Phosphorus,	0·25	
Schreibersite,	0·08	
Chrysolite?	0·11	
Copper,	?	
Tin,	?	
Sulphur,	?	
	99·85	98·63

10. *Santa Rosa*, 60 miles northeast of Bogota, New Grenada. Found in 1810 by Cecelia Corridor. Described by Rivero and Boussingault in 1823. Weight 1575 lbs., besides which several smaller masses were found in the same vicinity. Malleable, vesicular, resembling that from Rasgata. Sp. gr. = 7·30. Analysis by Riv. and Bouss.

Iron,	92·23
Nickel,	8·21
Insoluble,	0·28
	99·72

11. *Zacatecas*. Described in the Gazeta of Mexico, April 3d, 1792. Weight about 2000 lbs. This is mixed with an unusually large quantity of pyrites, partly in globular masses which are connected together by the same mineral, so as to form on polished surfaces a sort of imperfect network. Widmannstättian figures are not to be detected. Sp. gr. = 7·55, Rumler. Analysis by Bergemann.

Iron,	85·094
Nickel,	9·895
Cobalt,	0·668
Copper,	0·030
Magnesium,	0·187
Carbon,	0·164
Graphite,	0·334
Schreibersite,	1·646
Chrom. iron,	1·482
Sulphur,	0·845
Manganese,	?
	99·348

Nickeliferous iron,	93·77
Magnetic pyrites,	2·27
Chrom. iron,	1·48
Schreibersite,	1·65
Carbon,	0·49
	99·66

12. *Bohumilitz.* Found in 1829. Described in 1830. Weight 103 lbs. Preserved in the National Museum at Prague. Was covered with a thick crust of limonite. It is composed of a metallic mass, a large quantity of magnetic pyrites and an unknown substance, which is black, not very hard and not graphite. The black mineral occurs in the interior as well as at the surface of the mass, sometimes in portions nearly an inch in length, and is intimately mixed with finely divided metal and pyrites. These black masses are enclosed in a coating of magnetic pyrites. Analysis by Berzelius.

Iron,	92·473	94·775
Nickel,	5·667	3·812
Cobalt,	0·235	0·203
Insoluble,	1·725	2·200
	100·000	100·000

Berzelius dissolved 60 grammes of filings from the mass in nitric acid, and found, of insoluble carbonaceous matter, 0·672 grammes, and of crystalline magnetic scales, 0·777 grammes. The first contained carbon, alumina, silica, iron, nickel, phosphate and chromate of iron. The second consisted of

Iron,	65·987
Nickel,	15·008
Silicon,	2·037
Carbon,	1·422
Phosphorus,	14·023
	98·467

This is the substance which is now regarded as a phosphuret of iron and nickel called Schreibersite by Patera, after von Schreibers.*

13. *Bahia*, Brazil, 10° 30′ S. lat., 33° 15′ W. long. from San Salvador. Discovered by Bernardus da Mota Botelho in 1784. Described by A. F. Mornay in 1816. This mass was seven feet long, four wide and two thick, and weighed 17,300 lbs. Exhibits imperfect Widmannstättian figures and contains small quantities of magnetic pyrites. Analysis by Wollaston.

Iron,	94
Nickel,	4
	100·

15. *Black Mountain*, North Carolina.—16. *Crosby's Creek*, Tenn. According to Prof. Wöhler, the specimens of this meteorite bear a striking resemblance to those of the mass from Szlanicza.—17. *Tucuman*, Argentine Republic. Described by Don

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* But previously called dyslytite by Shepard in his Report on American Meteorites

Miguel Rubin de Celis in 1783. Weight 30,000 lbs. A mass weighing 1400 lbs. in the British Museum is believed to be from the same locality. This mass was covered with a crust of oxyds four to six inches thick, on the under side. It has cavities of various sizes, which are more or less filled with magnetic pyrites. Structure highly crystalline, and when etched presents surfaces resembling crystalline masses of antimony and bismuth. It is very malleable. G.=7·54–7·6, Rumler. Analysis by Howard.

Iron,	90
Nickel,	10
	100

18. *Senegal*, the Upper Senegal, Africa. Made known by Compagnon in 1717. Vast quantities are said to be scattered over the countries in the Bumbuk and Siratik countries, several pieces of which have been brought by the negroes to Fort St. Louis at the mouth of the Senegal. Compact, with a very slight admixture of magnetic pyrites. By etching, short raised lines appear, which are parallel or intersect each other at various angles presenting like the Tucuman iron, a striped or plumous appearance. When deeply etched the surface becomes granular. G.=7·72, Rumler. Analysis by Howard.

Iron,	95
Nickel,	5
	100

19. *Cape of Good Hope*, between Sunday and Boschesman's rivers, Cape Colony, Africa. Discovered in 1793. Described by Barrow in 1801, and by van Marum in 1804. The original mass weighed over 300 lbs., of which 171 lbs. are now in the cabinet of Natural History at Haarlem in Holland. Capt. Alexander discovered in 1837 great numbers of metallic masses, supposed to be meteoric, over a large extent of country along the Great Fish River in Cape Colony, which are supposed to belong to the same fall with the above. Compact, with a small quantity of finely divided magnetic pyrites. When etched exhibits no Widmannstättian figures. G.=6·63–7·94, Rumler. Analysis by Wehrle.

Iron,	85·608
Nickel,	12·275
Cobalt,	0·887
	98·770

20. *Lenarto*, Hungary. Found in 1814. Weight 194 lbs., (Austrian,) of which 134 are now in the National Museum at Pesth. It possessed an irregular, tabular form, and was highly crystalline. It was covered with a crust of dark brown metallic oxyds, and contained three empty cavities. It contains magnetic

pyrites in the form of small grains and lines, as well as in larger, reniform and cylindrical masses. Widmannstättian figures very distinct, which are mostly isosceles triangles, the bands crossing at angles of about 77° and 26°. Gr. = 7·73, Rumler. Analyses:

	Clark.	Wehrle.
Iron,	90·153	90·883
Nickel,	6·553	8·450
Cobalt,	0·502	0·665
Manganese,	0·145	
Copper,	0·080	99·998
Tin,	0·082	
Sulphur,	0·482	
Phosphorus,	?	
Insoluble phosphurets,	1·226	
	99·223	

Two analyses were made of filings from this meteorite, of which the mean result is given above. For one analysis 5·74 grms. were taken, and for the other 2·074 grms. The method employed was, in general, like that adopted in the analysis of the Hommoney Creek meteorite. The sulphur was determined as sulphuret of silver, and sulphate of baryta. The tin and copper were precipitated by sulphuretted hydrogen, roasted, reduced with carbonate of soda and borax, and tested, both in the wet and in the dry way. The iron was precipitated as succinate. In washing the precipitate, a small quantity was dissolved, although the solution had been rendered exceedingly basic before the addition of the neutral succinate of ammonia, and then heated to boiling before filtration. This was probably owing to the presence of phosphoric acid, which appears almost invariably to be formed by the solution of meteoric metal in hydrochloric acid. The nickel, cobalt and manganese were thrown down by hydrosulphuret of ammonia, and the solution allowed to stand till it became colorless and clear, when it was filtered off, and evaporated almost to dryness. A few drops of hydrosulphuret of ammonia now precipitated a small quantity of nickel. The sulphurets were then dissolved in aqua regia, and thrown down by potassa. After weighing, the oxyds were redissolved in hydrochloric acid, reprecipitated by potassa, brought upon a filter and washed. The moist oxyds of nickel and cobalt were then dissolved upon the filter by a mixture of solutions of potassa and prussic acid, the manganese remaining undissolved. The solution was boiled to expel the excess of prussic acid, and to change the cyanid of cobalt and potassium, to sesquicyanid. The nickel was then precipitated by boiling with freshly prepared oxyd of mercury. The cobalt was determined qualitatively by neutralizing the alkaline filtrate with nitric acid, and throwing down the cobalt by means of nitrate of suboxyd of mercury; and quantitatively by the loss. The black, flocky, insoluble residue was digested in hot nitric acid, and was completely dissolved with the exception of a few pieces of a mineral, which might have been chrysolite; though perhaps only quartz mixed with the filings. The solution contained phosphoric acid, iron and nickel.

21. *Agram*, (Hraschina) Croatia. This most interesting meteorite, which fell May 26, 1751, and for nearly 100 years was the only one of the metallic class positively known to have fallen from the heavens, was first seen as a brilliant fire-ball passing from west to east through a cloudless sky at 6 P. M., attended with a noise like that produced by heavy wagons rapidly passing over a paved road. When almost directly over the village of Hraschina, it burst with a tremendous explosion into two pieces, and at the same moment became enveloped in a cloud of smoke, which was at first black, and then presented a variety of colors. The fall was followed by a terrible crash, and a trembling as from an earthquake. The larger fragment, which weighed 71 lbs., (Austrian,) made an opening in the earth 18 feet deep and 2 feet wide, while the smaller of 16 lbs. weight buried itself in a meadow 2000 paces distant. The large mass was presented to the Emperor Francis I, and the Empress, Maria Theresa, by the Bishop of Agram, and is preserved in the Imperial Museum at Vienna: the smaller mass is missing. The mass has a triangular, tabular form, with one side convex and the other slightly concave. It has a complete crust, in which is enclosed no gravel or earthy matter, as must have been the case had it been in a liquid condition. It undoubtedly came to the earth in a glowing state, and revolving rapidly like a circular saw, so as to strike the ground edgewise, and thus penetrate to such an astonishing depth. The surface presents the usual concavities. The crust is brownish-black and without lustre, with a thickness of about three-fourths of a line, though varying on different parts. It is somewhat fibrous in structure, and readily separated from the metal beneath, which then appears smooth and polished. On the convex side of the mass, the crust contains numerous fissures, usually about one-half inch long, though rarely from one to two inches, and from two-twelfths to three-twelfths of a line deep. The mass contains occasional intermixtures of magnetic pyrites, and displayed on fractured surfaces a crystalline structure. When etched, it exhibits most perfectly those characteristic figures which were first discovered in this iron, by Widmannstätt in Vienna in 1808. Gr.=7·72 – 7·82, Rumler. Analyses:

	Klaproth.	Wehrle.
Iron,	96·6	89·784
Nickel,	3·5	8·886
Cobalt,		0·667
	100·1	99·337

22. *Elbogen*, near Carlsbad in Bohemia. Described by Neumann in Prague in 1811. This mass was for many years preserved in the town-house at Elbogen under the name of "the enchanted Burgrave," and therefore probably fell about the close of the 14th century, when for a few years Elbogen was governed by burggraves. It weighed 191 lbs., 141 lbs. of which are now in Vienna and 11½ in Prague. It was described by Chladni as having resembled a horse's head. It contains here and there, small masses or veins of magnetic pyrites. When etched, it exhibits the Widmannstättian figures. Gr. =7·74, Rumler. Analysis by Berzelius.

	Metal.		Insoluble.
Iron,	88·231		14·17
Nickel,	8·517		17·72
Cobalt,	0·762		
Magnesium,	0·279		?
Phosphurets,	2·211	Phosphorus,	14·17
Sulphur,	?		
Manganese,	?		
	100·00		

23. *Otsego County*, N. Y.—24. *Ruff's Mountain*, S. Car.—25. *Szlanica*, near Arva, Hungary. Found in 1843. Described by Haidinger in 1844. Discovered in digging for iron-ore, and was invested by a thick crust of hydrated oxyd of iron, in which were observed a few crystals of vivianite. The mass consists of a multitude of small, ellipsoidal globules of metal, apparently cemented together by thin veins of pyrites and crystalline plates of schreibersite. The pyrites occurs also, in small, compact masses. When etched on polished surfaces, it displays no Widmannstättian figures, but becomes dull and of a light gray color. The edges of the plates of schreibersite appear upon such surfaces as brilliant lines and bands, arranged without order and of various dimensions, sometimes being half an inch in length, and one-twelfth in thickness. Analysis by Patera and Lowe.

Iron,	89·42		90·471
Nickel, Cobalt,	8·91		7·321
Schreibersite, Silicon, Carbon, Copper, Sulpher.	1·41	Cobalt, Schreibersite, Silicon, Carbon, Sulphur,	1·404
	99·44		99·169

The schreibersite, Patera. Magnetic, elastic, bronze-yellow plates. H. =6·6. Gr. 7·01–7·22.

Iron,	87·20
Nickel,	4·24
Phosphorus,	7·26
Carbon,	?
	98·7

26. *Seeläsgen*, near Schwiebus in Silesia, Austria. Described by Göppert in 1847. Found in ditching a meadow among boulders of primitive rocks, fourteen feet beneath the top of the ground; and was sold for old iron to a blacksmith. Weight 218 lbs. It was covered with a dark brown crust of oxyds from one-fourth to three-fourths of a line in thickness. The indentations upon its surface were quite striking. The metal is malleable, homogeneous, of a light steel gray color, and contains an unusual quantity of a very insoluble pyrites, which is disseminated through the mass in irregular veins, in long, cylindrical portions, and in minute spherical globules. This pyrites is of a grayish brown color, inclining to bronze-yellow, rarely tarnished pinchbeck brown or bluish, with a dull metallic lustre. The small globules are darker colored and more compact than the rest, so as to be capable of taking a polish. The streak is grayish black, and the cleavage, octahedral. Multitudes of zigzag seams run through the mass, sometimes forming cells, the surfaces of which are scoriaceous and jagged, and coated with an earthy substance of a blackish brown color. These cells also contain numerous spherical globules of pyrites, and according to Partsch, small isolated masses of metal. Where the cells open on the surface of the mass, may be seen numerous arborescent, metallic points, and the black earthy mineral is apparently changed to hydrated oxyd of iron. The fracture is lamellar in one direction, but otherwise granular. Etched surfaces appear rough and granular, exhibiting only a few short fine, parallel, depressed lines, but no Widmannstättian figures. H.=4. Gr.=7·63–7·73. Gr. of pyrites =4·787, Rammelsberg. Analyses:

	Duflos.		Rammelsberg.
Iron,	90·000	-	92·307
Nickel,	5·308	-	6·228
Cobalt,	0·434	-	0·667
Manganese,	0·912	Tin,	?
Copper,	0·103	-	0·049
Silicon,	1·157	-	0·026
Schreibersite,	0·834	-	0·183
Graphite,		Carbon,	0·520
Chromium,	?		?
	98·749		100·000

Rammelsberg infers from his analysis that the pyrites is a simple sulphuret, Fe S. Its composition is,

Sulphur,	28·155
Iron,	65·816
Nickel,	1·371
Cobalt,	1·371
Copper,	0·566
Protox. iron,	0·874
Chrom. iron,	0·858
	100·011

The insoluble portion after the separation of the silica and carbon, contains, according to Rammelsberg,

	(*a*)	(*b*)
Iron,	59·23	61·13
Nickel,	26·78	28·90
Copper,	0·78	?
Tin,	0·20	?
Phosphorus,	6·13	7·93
Sulphur,	?	0·26
	93·12	98·22

27. *Hauptmannsdorf*, near Braunau in Bohemia. Fell July 14th, 1847. Described by Beinert in 1847. At break of day, the inhabitants of Braunau and vicinity were startled by a violent, roaring sound, which continued for some minutes. A small, black cloud was observed over the village, which suddenly glowed as if on fire, and sent out flashes of light in all direction. Two fireballs fell from the cloud attended by two explosions, like the report of cannon. It having been reported that lightning had struck in a neighboring field, the place was visited, and a metallic mass found, which had buried itself to the depth of three feet in the earth, and which six hours after the fall was so warm, that it was impossible to bear the hand upon it. It was subsequently found also that a dwelling-house, half a mile from Braunau had been struck, and that another fragment of the meteor had broken through the roof, passed through the chamber in which persons were sleeping and buried itself in the side of the house. The larger mass weighed 42 lbs. 3 oz. (Austrian), the smaller, 30 lbs. 8 oz. The former was cut up for furnishing specimens to cabinets, the latter is still entire, and in the possession of the abbot of the monastery of Braunau. The larger fragment had the form of an irregular rhomboid; while the smaller resembles a huge oyster shell. Both were covered with more or less regular hexagonal concavities. The color is iron-gray, and in the concavities, reddish brown, from a small quantity of me-

tallic oxyds. It is highly crystalline within, so that it may be cleaved in three directions, parallel to the faces of a cube almost as easily as galena. A piece from the larger mass in the Imperial Museum at Vienna weighs about 4 lbs., and is described by Haidinger as being apparently an individual crystal. The metal is remarkably homogeneous, and presents to view on etched surfaces, three series of fine parallel lines, which intersect each other in the usual manner. It is malleable, very hard, and of light steel-gray color. Gr. = 7·71. Analysis by Duflos and Fischer.

Iron,	91·882
Nickel,	5·517
Cobalt,	0·529
Manganese, Copper, Arsenic, Calcium, Magnesium, Silicon, Chromium, Sulphur, Phosphorus, Carbon, Chlorine,	2·072
	100·000

28. *Asheville,* N. C.—29. *Caille,* near Grasse, Dept. du Var, France. Discovered to be meteoric by Brard in 1828, though it had served as a bench before the parish church for more than 200 years. It is crystalline and cleavable; and contains a small quantity of magnetic pyrites. The figures brought to view by etching are bounded not by straight, but by sinuous, raised lines. Gr. = 7·64. Analysis by De Luynes.

Iron,	82·63
Nickel,	17·37
Copper,	?
Manganese,	?
	100·00

30. *Durango,* Mexico. Described by A. von Humboldt in 1811. Weight 30,000 to 40,000 lbs. The mass lies in the city of Durango; only a few small specimens having been detached from it. It is compact, but exceedingly cleavable; and incloses a small quantity of magnetic pyrites. Very perfect Widmannstättian figures are visible on etched faces. The bands are often so wide and so near together as to have scarcely any intervening spaces. Gr. = 7·88, Rumler.—31. *Claiborne,* Ala.—32. *Schwetz,* on the

river Weichsel, Prussia. Found in 1850. Described by G. Rose in 1851. Weight 43 lbs. 4 oz. Discovered in excavating a sand-hill on the line of the East Railroad, at the depth of four feet. It had the form of a right rectangular prism, with rounded edges. It was inclosed in a thin crust of hydrated oxyds, and intersected by two or three seams, so that by means of chisels and hammers, it was easily divided into three pieces. The most of it is preserved in the Royal Museum at Berlin. The metal incloses a few small masses of magnetic pyrites. It exhibits when etched, the Widmannstättian figures very perfectly, the whole surface being ornamented by two sets of very long, straight bands one-eighth of an inch wide, which cut each other at angles of 60 and 120°, while a third set much wider and shorter, intersect these somewhat irregularly. Gr. = 7·77, Clark. Analysis by Rammelsberg.

	Metallic portion.		Insoluble part.
Iron, -	93·18	- -	22·59
Nickel, -	5·77	-	34·77
Cobalt, -	1·05	Copper,	4·74
Insoluble, -	0·96	Chromium,	3·90
		Phosphorus,	34·13
	99·98		
			100·13

33. *Texas.*—34. *Carthage*, Tenn.—35. *Guildford*, N. Car.—36. *Burlington*, N. Y.—Prof. Clark gives a new analysis of this very beautiful meteorite, so remarkable for the white color of its metal and the peculiar pattern of its etched surfaces.

Iron, - - - -	89·752
Nickel, - - -	8·897
Cobalt, - - - -	0·625
Copper, - - - -	?
Manganese, - - - -	?
Insoluble phosphurets, - -	0·703
	99·977

37. *Xiquipilco*, north of Toluca, Mexico. Mentioned in 1784 in the Gazeta de Mexico, in which it is said that small pieces from a few ounces to 50 lbs. in weight were very numerous; that these were sought for by the Indians after heavy rains, and used by them for the fabrication of agricultural implements. It is compact and without any visible intermixture. It presents the Widmannstättian figures very perfectly. Gr.=7·72, Rumler. Analysis by Berthier.

Iron, - - - -	91·38
Nickel, - - - -	8·62
	100·00

According to Manross, it contains cobalt.—38. *Sierra Blanca*, Mexico. Mentioned in the Gazeta de Mexico in 1784, where it is stated that masses of native iron weighing 2000 lbs., 3000 lbs., and even more, had been found among these mountains. When etched, exhibits Widmannstättian figures, similar to those on the Durango mass.—39. *San José del Sitio*, Mexico. Discovered by Sonneschmidt in the corner of a church-yard in Charcas, partially buried in the earth. The projecting portion was 2½ feet long and one foot in diameter. It was said to have been brought from the estate of San José del Sitio, where several masses had been found imbedded in a limestone, probably of tufaceous origin.—40. *Jackson County*, Tenn.—41. *Babb's Mill*, Tenn. Prof. Clark reanalyzed this iron, detecting 2·037 p. c. of cobalt, and making the proportion of nickel as high as 17·1 p. c.—42. *Chesterville*, Chester county, S. Car.—43. *Murfreesboro'*, Tenn. —44. *De Kalb county*, Tenn.—45. *Charlotte*, Tenn.—46. *Smithland*, Tenn.—47. *Grayson county*, Va.—48. *Roanoake county*, Va.—49. *Oaxaca*, Mexico. Described by Partsch. Brought from Mexico by Baron Karawinsky of Munich. The metal is compact, and exhibits on etched surfaces crooked bands, the crystalline structure having been apparently distorted by hammering. Gr.=7·38, Rumler.—50. *Greenland.* Described by Capt. Ross in 1819. The attention of the Captain was attracted to it by the fact that the Esquimaux of the coast used implements of iron. Upon inquiry he learned that they procured the material from a large mass of native metal lying thirty miles inland, near which they informed him was a huge stone containing globules of metallic iron. It is very malleable, silver-white, and not easily oxydized. It contains nickel, pyrites, and a black unknown mineral, and when etched, exhibits fine crooked bands, the original structure having been distorted by hammering. Gr.=7·23, Rumler. According to Brande contains 3 p. c. of nickel.

51. *Petropawlowsk*, Altai, Siberia. Described by Sokolowskji in 1841. Several small specimens of meteoric metal were found at the depth of 31½ feet below the surface. The largest mass was of irregular form, and coated with a crust of hydrated oxyds. Its weight was 17½ lbs. Gr.=7·76. Analysis by Sokolowskji.

Iron, - - - -	97·29
Nickel, - - - -	2·07
	99·36

52. *Alasej mountains*, Siberia. Large quantities of excellent iron are said to be found among these mountains and to be employed by the natives in the manufacture of knives, wedges, etc. —53. *County Down*, Ireland?—54. *Scriba*, N. Y.—55. *Walker county*, Ala.—56. *Randolph county*, N. Car.—57. *Bedford county*,

Penn.—58. *Pittsburg*, Penn.—59. *Salt River*, Kentucky.—60. Locality unknown. A specimen weighing two ounces, and found among the minerals of Prof. Stromeyer, by Prof. Wöhler of Göttingen. Gr.=7·547. Analysis by Manross.

Iron,	92·33
Nickel, Cobalt,	7·38
Tin,	0·03
Phosphuret of Iron and Nickel,	0·42
	100·16

Prof. Clark has omitted to mention the St. Augustine's Bay, Madagascar, locality of meteoric iron, where the quantity is reported to be immense;* and since the publication of his paper has appeared in the proceedings of the 6th meeting of the Amer. Association published the present year, the notice (p. 188) by Dr. Le Conte of two large pieces of meteoric iron seen by him while passing through the village of Tucson, a frontier town of Sonora, near the Gila.

ART. III.—*Remarks on the Distortion of the Achenium in certain species of Carex;* by JOHN CAREY.

SOME time ago, when preparing an arrangement of the genus Carex, for Dr. Gray's *Manual of the Botany of the Northern United States*, I observed that the specimens, in his herbarium, of *C. crinita*, Lam., *var. paleacea*, had the achenia variously distorted. Supposing, however, that this might be accidental, I took no notice of the fact in my description of the species, and had almost forgotten the circumstance when my attention was recalled to it by some specimens received from Northern New York. Finding in these the same anomaly, I have since carefully examined such specimens as have fallen under my notice, and I now submit the result of my observations, which, as I have not met with any allusion to the subject, may be of some interest to botanists.

The normal shape of the achenium, in C. crinita is lenticular and slightly obovate (fig. 1); but this I have scarcely ever observed in the var. *paleacea*, the most common form in the Northern and Eastern States, distinguished by the *very long* awn of the scales. In this variety I find the achenia to exhibit almost every gradation from the nearly perfect type, to the most distorted form.

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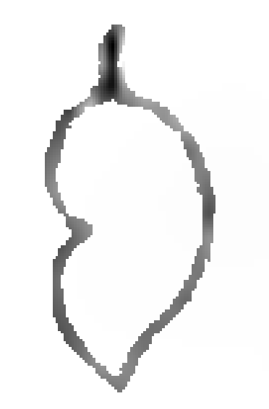
* See Proceedings of Amer. Association of the Geologists, at New Haven, April, 1845, p. 40.

The deformity appears, most generally, to consist in an imperfect development of the albumen, on one side; causing an indentation, which, at maturity, bends down the apex of the achenium, rounding, proportionably, the perfect side. (Fig. 2, *in the young state*, fig. 3, *at maturity*.) But this, though the most common, is by no means the constant appearance presented, as I notice that the achenium is sometimes indented on *both* sides, and it is then completely panduriform at maturity, (fig. 4.) Occasionally it is doubled across the widest surface or face of the achenium, (fig. 5, *longitudinal section;*) but there are many modifications of all these irregularities of which I merely describe the principal forms. The perigynium, being somewhat inflated, is not exactly conformed to the misshapen achenium. Sometimes it is partially so, but usually it presents an irregular, rounded outline.

1.

2.



3.

4.

5.

This remarkable anomaly led me to examine such specimens as I possess of the closely allied species, C. maritima, *Vahl.*, and C. salina, *Wahlenb.*, both of which have long-awned scales. Of the first, I have a single mature specimen from Sweden; also a specimen (probably American) from the herbarium of Dr. Torrey, and two or three perigynia from a specimen, in the same, collected by Richardson in the Hudson's Bay region. The whole of these exhibit the same extraordinary contortion of the achenium. Some Norwegian specimens, in my herbarium, are too young to determine the question, as I do not notice the deformity in an early state of the ovary. Of C. salina, I have a single specimen from British North America,* and another from Sweden, both showing the same distortion; and the latter has a seta arising from the base of the achenium, but not exserted through the orifice of the perigynium. A very young specimen of Hornemann's (probably from Greenland) has the ovary apparently bent. With respect to these two very uncommon species, I have not the means of ascertaining whether the plants having perfect achenia are found with shorter-awned scales, a question more readily determinable by the botanists of Northern Europe, than with us. Kunth, (*Cyp. Synopt.*) under C. maritima, says, "Achenium immaturum *oblique* obovato-oblongum," and this

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* This is one of the original specimens from Cumberland House, to which Dr. Boott (Flor. Bor.-Amer.) correctly refers C. lanceata, *Dewey;* founded, in part, upon this species, mixed up with young specimens of C. livida, *Willd.* The original character of C. lanceata seems to have principal reference to the latter, it being described as tristigmatic, by the author, who also notices its resemblance to his C. Grayana, correctly referred, I conceive, to C. livida. The "staminate spikes 1–3," and possibly some other parts of the character of C. lanceata, belong to C. salina, a distigmatic species

was, probably, the early appearance of the distortion; but he does not seem to have seen ripe specimens. He also describes a Brazilian species, C. procera, with a "mucronate-subaristate" scale, of which he says, "Ovarium oblongum, triangulare, ad unum latus versus medium emarginato-incisum. Achenium oblique oblongum, triangulare, ad angulum rectilineum versus medium emarginato-incisum (semper?)." This species is altogether unknown to me, and I am indebted to my friend, Dr. Boott, of London, for the reference—but, it belongs to a very different group from those to which I have referred, being tristigmatic, and described as "C. ripariæ et C. paludosæ similis et affinis."

It is not my intention, in these remarks, to speculate upon the cause of this malformation, but merely to call the attention of botanists to the subject, more especially with reference to C. crinita, which is so universally diffused throughout the United States. Assuming that the plants with shorter awns, bearing perfect and regular achenia, are to be taken as the type of the species, I conceive that the very prolonged awn is an irregular (morbid?) appearance, consequent, probably, upon the disturbing causes, whatever these may be, to which the distorted achenia are attributable. I have imagined that the lengthened awn might be somewhat analogous to the irregular hairs found upon various galls, on the leaves and branches of plants. I have not, however, been able to detect any appearance of injury from insects, or otherwise, in the variety *paleacea*, which, as I have remarked, seems to be the more common form in the Northern States, and is equally robust and vigorous in growth with the regular type of the species. It would be interesting to find a specimen in which *one* or *two* of the fertile spikes should present the long-awned scales, accompanied by the distorted achenia, whilst the remainder were in the normal condition; but this I have never observed; nor yet a regular spike on the paleaceous form of the species. In C. stricta, *Lam.*, a species of this group, it is not uncommon to find both perigynium and achenium tumid and enlarged, but without distortion in the shape of the latter, or prolongation of the scale, so far as I have observed.

I learn from Dr. Boott, who has seen an authentic specimen, that C. paleacea, *Wahl.*, is referable to C. maritima, and it will therefore be proper to drop that name for the long-awned variety of C. crinita, which, if my views should be confirmed by the observation of botanists, may be distinguished as C. *crinita*, var. *morbida.*

Art. IV.—*On the Reproduction and supposed Existence of Sexual Organs in the Higher Cryptogamous Plants;* by Arthur Henfrey, F.L.S.

[Concluded from vol. xiv, p. 389.]

Lycopodiaceæ.—The fructification of this family consists, as is well known, of spikes clothed with fruit-leaves, bearing on their inner faces sporangia containing spores. These spores are of two kinds. One sort occur in large numbers in their sporangium, and are very small; the others are much larger, and only four are met with in a sporangium. Spring,* who has devoted great attention to the general characters of the Lycopodiaceæ, has given especial names to the two kinds of sporangia; those with the four large spores he calls oophoridia, those with the small spores antheridia; yet he did not mean to attribute a sexual antithesis, merely a morphological one, as he expressly states.

The general impression, however, with regard to the import of the two kinds of spores has long been, that the large spores alone are capable of producing new plants; and five years ago Dr. C. Müller published an elaborate account of the development of the Lycopodiaceæ,† in which the germination of the large spores was described at length. The following are the essential results of his investigations.

The large spores are more or less globular bodies, usually flattened on the surfaces by which they are in contact in the oophoridium; thus, while the outer side has a spherical surface, the inner side has three or four triangular surfaces, as in *L. selaginoides*, and *L. denticulatum.* They possess two coats, the outer very thick and composed of numerous cells, the cavities of which are almost completely filled up by deposits of secondary layers. This outer coat exhibits various forms of raised markings on its outer surface, and in some cases these seem to form a distinct layer, a kind of cuticle, capable of being separated from the subjacent cells. The inner coat of the spore is *usually* perfectly structureless, and not very firmly attached to the outer coat. In *L. gracillium,* Dr. Müller observed below the outer coat a structure composed of a layer of rather large parenchymatous cells, which could be easily isolated; and as there was no structureless membrane within this, he regarded the layer as the proper inner coat. This observation is important in relation to the discrepancies between Dr. Müller's statements and those of Mettenius, to be spoken of presently. The cavity of the spore is filled with granular mucilage.

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* Flor. Brasiliensis, 106–108.

† Botanische Zeitung, July 31, 1846, *et seq. num.* Ann. of Nat. Hist., vol. xix, 1847.

When the spore is placed in favorable circumstances for germination it begins to swell up, and if the contents be examined with the microscope, a few minute cells will soon be found to have become developed in the mucilage. This cell-formation commences at a determinate spot upon the inner coat of the spore, the cells being so firmly applied that they appear blended with this inner membrane. The cell-formation goes on till an obtuse conical process is developed, which breaks through the outer tough coat of the spore, and this process is recognized as the germinal body, or *keim-körper*, corresponding to the pro-embryo of the other Cryptogams. From this, which at this period does not by any means fill the cavity of the spore with its lower portion, an ovate process is produced, at first obliquely directed upwards, the bud of the future stem, and a conical process taking the opposite direction representing the radicle. On the ascending process a distinction can soon be observed between the terminal bud, a little oval body, and a short thread-like stem on which it is supported; as the bud opens, the leaves appear in pairs.

At the conclusion of the paper, Dr. Müller offers some remarks on the evidence with respect to the import of the spores, the substance of which may be transcribed. "Up to the present time it remains doubtful what purpose is served by the antheridium-spore. Some persons maintain one opinion, others another. One author declares he has seen it germinate, another that he has never been able to do so. Kaulfuss* relates that Fox sowed *Lyc. elago*, and Lindsay *L. cernuum* with success, and that *L. clavatum* sprung up abundantly with Willdenow. With himself it did not succeed; but the garden-inspector, Otto of Berlin, raised *L. pygmæum* several years in succession from seed. The last case however is readily explicable, since *L. pygmæum* possesses oophoridia."

Göppert† however states that he has seen the development of young plants from antheridium-spores in *L. denticulatum*. Dr. Müller expresses some doubt as to whether the observation was absolutely exact, since Göppert never mentions seeing a young plant actually adherent to an antheridium-spore, neither does he give the structure of the leaf, and the young plant he figures closely resembles a *Fissidens*, frequently springing up in flowerpots in green-houses. In his own attempts to raise plants from antheridium-spores, Dr. Müller in every case failed. He does not deny, however, that they may be capable of germination, especially as some Lycopodiaceæ appear to be devoid of oophoridia.

In 1849 appeared M. Hofmeister's notice on the fructification and germination of the higher Cryptogamia,‡ in which he indicated the existence on the pro-embryo of *Selaginella*, of a number

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* Das Wesen der Farrenkräuter. Leipzig, 1827.

† Ubers. der Arbeiten und Veränd. der schlesischen Gesellsch. für vaterl. Kultur, 1841 und 1845.

‡ Bot. Zeitung, Nov. 9, 1849.

of peculiar organs, composed of four papilliform cells, enclosing a large globular cell in the centre. In one of these large spherical cells the young plant is produced. The nature of the structure was only briefly described in this paper for the purpose of showing its analogy with what occurs in *Salvinia*.

In 1850, Dr. Mettenius* published an essay on the Propagation of the Vascular Cryptogams, and in this is to be found a full description of the organs mentioned by Hofmeister and altogether overlooked by Dr. C. Müller. According to this author, the large spores of *Selaginella involvens* possess two coats, each composed of two layers; and in an early stage of the germination, the inner layer of the outer coat, together with the inner coat, form the walls of a globular body which does not wholly fill the cavity enclosed by the outermost membrane. This globular body is firmly attached to the outer membrane immediately under the point of junction of the three ridges separating the flattened surfaces of the inner side of the spore. The globule enlarges until its walls come to be applied closely to the outer layer, completely filling up the large cavity. Then between the two layers of the inner coat, at a point immediately beneath the point of junction of the three external ridges, a process of cell-formation commences, producing a flattened plate of tissue interposed between the two layers; this structure is the pro-embryo. The cells are at first in a single layer, but the central ones soon become divided by horizontal septa so as to produce a double layer, and finally four or more tiers of cells one above another. The outline of the pro-embryo, seen from above, is circular, spreading over the upper part of the spore. On its surface appear the so-called ovules. The first is produced at the apex of the pro-embryo, the rest, to the number of twenty or thirty, arranged upon its surface in three lines corresponding to the slits by which the outer coat of the spore bursts. These ovules, closely resembling those of *Salvinia*, *Pilularia*, the Ferns, &c., consist of a globular cell surmounted by four cells, which rise up into four papillæ, and leave a canal or intercellular passage between them, leading down to the globular cell or embryo-sac. The four cells are usually developed into four or five cells, one above the other, by the production of horizontal septa; sometimes they are developed unequally and to a considerable extent so as to form papillæ, presenting an orifice between them at some point on the outer surface, indicating the canal leading down to the embryo-sac.

During the development of the ovules, a delicate parenchyma is produced in the great cavity of the spore, finally entirely filling up this spore. Before it has completely filled it, the embryo makes its appearance in the embryo-sac of one of the ovules.

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* Beiträge zur Botanik. Heidelberg, 1850.

The first change in this sac is the appearance of a nucleus; from this cells are developed representing the suspensor of the embryo. The cells of the suspensor multiply and form the process which penetrates down into the parenchyma of the cavity of the spore; at the lower end may be detected the embryo, a minutely cellular body. Dr. Mettenius never saw the embryo produced in the embryo-sac before the suspensor had broken through the bottom of it to penetrate the parenchyma of the spore-cell; it was always within this parenchyma and attached to the end of the suspensor. In this point he is decidedly opposed to Hofmeister, who states that the embryo originates in the embryo-sac, whence a young embryo attached to its suspensor may easily be extracted from the spore.

The part of the embryo opposite to the point of attachment of the suspensor corresponds to the first axis of the Rhizocarpeæ, which never breaks out from the spore-cell in *Selaginella;* it pushes back the loose parenchyma of the spore-cell as it becomes developed, and when completely formed, is surrounded by a thin coat composed of several layers of the parenchymatous cells much compressed, enclosed in the still existing inner coat of the spore. On one side of the point of attachment of the suspensor the embryo grows out towards the point where the spore-cell has been ruptured, thus apparently in a direction completely opposite to the end of the axis. As it enlarges it produces in this situation the leafy stem growing upwards, and the adventitious root turning downwards. The pro-embryo is at first distended like a sac, and finally broken through on the one side by the first leaf, on the other by the adventitious root; upon it may be observed the numerous abortive ovules, with their embryo-sacs filled with yellow contents; part of its cells grow out into radical hairs. Dr. Mettenius several times saw two young plants produced from one spore; the ends of their axes lay close together, and separated inside the cavity of the spore. No account is here given of the characters exhibited by the small spores, or of anything like a process of fertilization; yet we have indicated in the foregoing description of the so-called ovules, a clear analogy between these bodies and the so-called ovules of the Ferns and Rhizocarpeæ. These points will be referred to again at the close of the report.

In a review of Dr. Mercklin's essay on the reproduction of the Ferns, in the Flora,* Hofmeister states that spiral filaments are produced from the small spores of *Selaginella*, but does not state that he has seen them, or give any authority.

Isoëtaceæ.—The spores of the *Isoëtes lacustris* are of two kinds, analogous to those of the Lycopodiaceæ; both kinds being produced in sporangia imbedded in the bases of the leaves, but the

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* Flora, 1850, p. 700.

large spores are found in great numbers, not merely four in a sporangium as in the Lycopodiaceæ. The development of the spores was little known until the publication of an essay on the subject in 1848, by Dr. C. Müller,[*] forming a sequel to his researches on the Lycopodiaceæ. Here, as in the other case, his observations on the earlier stages were imperfect; but he indicated the existence of the structures which have since been recognized as the so-called ovules; as also did Mr. Valentine[†] in his essay on *Pilularia*.

In his essay Dr. C. Müller compares the complete large spore, as discharged from the sporangium, with the ovule of flowering plants; and he describes it as a globular sac enclosed by three coats, which he names the primine, secundine, and the nucleus. The outermost coat, or primine, is stated to be composed of a thick cellular membrane exhibiting a raised network of lines, which give it the aspect of a cellular structure, but are in reality analogous to the markings on pollen-grains. The outer surface exhibits the lines indicating the tetrahedral arrangement of the spores in the parent cell, as in *Selaginella*, and it is at the point of intersection of these that the membrane gives way in germination. The next coat, or secundine, is another simple membrane lining the first. The nucleus is a coat composed of delicate parenchymatous cells, but among these are found groups of a peculiar character. These are described as consisting of a large cell divided by two septa crossing each other at right angles, projecting from the general surface, being either oval in the general outline, or having four indentations opposite the cross septa, so as to give the appearance of the structure being composed of four spherical cells. The cells surrounding them are of irregular form, different from the generally six-sided cells of the rest of the nucleus. Many of these groups occur on the nucleus, always at the surface of the coat where the primine and secundine afterwards give way, scattered without apparent order over it, but one always near the point of the opening. To these structures Dr. Müller did not attribute any important function, explaining them merely as produced by peculiar thickenings of the tissues to protect the proembryo during germination. The contents of the nucleus were stated to resemble those of the cavity of the spore of *Selanginella*.

In these contents, which become dense and mucilaginous, a *free* cell is developed near the upper part of the cavity; this is the rudiment of the embryo, and by cell-multiplication becomes a cellular mass, which soon begins to exhibit growth in two directions, producing the first leaf and the first rootlet, projecting from a lateral cellular mass, which the author calls the "reservoir of

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[*] Botanische Zeitung, April and May, 1848; Annals of Nat. History, 2nd ser. vol. ii, 1848.

[†] Linnæan Transactions, vol. xvii.

nutriment." The embryo then breaks through the coats; the first leaf above and the first root below, the coats remaining attached over the central mass of the embryo. The subsequent changes need not be mentioned here, further than to state that the leaves succeed each other alternately, and are not opposite as in the Lycopodiaceæ; moreover no internodes are developed between them, so that the stem is represented by a flat rhizome, like the base of the bulb of many Monocotyledons.

In the paper by Dr. Mettenius,* already alluded to, we find some very important modifications of, and additions to, this history of development of the spores of *Isoëtes*, bringing them into more immediate relation with the other vascular Cryptogams.

This author describes the spore-cell as a thick structure composed of several layers; in some cases he counted four. It completely invests the pro-embryo, which is a globular cellular body filling the spore-cell. Among the cells of the outermost layer of the pro-embryo (which layer forms the *nucleus* of Dr. Müller), on the upper part, are produced the ovules, fewer in number than in *Selaginella*, arranged in three rows converging upon the summit of the spore, these rows corresponding to the slits between the lobes of the outer coat of the spore. The four superficial cells of the ovules (which are evidently the peculiar groups mentioned by Müller and previously noticed by Valentine)† grow much in the same way as in the Rhizocarpeæ and in *Selaginella*, into short papillæ. The embryo is developed in the substance of the pro-embryo, displacing and destroying its cells, and a globular portion (corresponding to the "reservoir of nutrition" of Müller) remains within the spore after the first leaf and rootlet have made their way out. This body is the analogue of that portion of the embryo of *Selaginella* which penetrates into the cavity of the spore, and to the end of the first axis in the Rhizocarpeæ.

The most important point, however, of Dr. Mettenius's researches relates to the phenomenon exhibited by the small spores. In the water in which the spores were sown he observed moving spiral filaments resembling those of the Ferns. He was not able to trace all the stages of development of these spiral filaments from the small spores, but he obtained nearly all the evidence relating to their origin which Nägeli has done in reference to the similar organs in the *Pilularia*.‡ In the small spores minute vesicles are produced of varying size and number, seen through the outer coat. The inner coat or spore-cell breaks through the outer coat either in the middle or at both ends at the projecting ridges, by which they are originally in contact with the other spore-cells. Its contents are expelled, as is proved by finding numerous empty membranes. The expelled vesicles are met with

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* Beiträge zur Botanik. Heidelberg. 1850. † Linnæan Transactions, vol. xvii.
‡ Zeitschrift für Wiss. Botanik, Heft 3. Zurich, 1846.

in considerable number in the water, and contain one large or several small granules, and in them the spiral filaments are apparently produced; but the actual course of development was not observed. In one case a spiral filament was seen half way out of the spore-cell in active rotation, finally emerging completely, so that the moving spiral filaments are probably developed in the vesicles, while these are still contained within the spore-cell.

No actual connection of these moving spiral filaments or spermatozoa with the so-called ovules has yet been traced.

Rhizocarpeæ.—Almost from the earliest period of the study of Cryptogamous plants, attempts have been made to prove the existence of distinct sexes in the Rhizocarpeæ, various parts of the structure being regarded by different authors as analogues of the stamens and pistils of flowering plants. Bernard de Jussieu[*] went so far as to class them (*Pilularia glob.* and *Marsilea quad.*) with the Monocotyledons, with *Lemna*, considering the large spore-sacs as pistils and the small ones as stamens.

Others have sought the male organs in the hairs upon the leaves or receptacles;[†] but the rest of the numerous authors who have written on the subject, have either denied the distinction of sexuality altogether, or are agreed in considering the large spores as either ovaries or ovules, the small spores as pollen-grains. Experiments have frequently been made upon the generative powers of the two kinds of spores. Paolo Savi[‡] found that the large spores of *Salvinia* would not germinate alone, and therefore he regarded the small ones as anthers. Duvernoy,[§] on the contrary, states that he saw the large spores of *Salvinia* germinate when separated from the small ones, and therefore he did not regard the latter as anthers, but only rudiments. Bischoff,[‖] who minutely described the structure of the European species, said that in his experiments the large spores of *Salvinia* germinated as well without the small granules as with them. Agardh[¶] saw the large spores of *Pilularia* germinate separately, but later than those united with the anthers. Pietro Savi[**] made careful observations on the germination of the separated large spores of *Salvinia*, and found them to produce a green mamilla which underwent no further development; he therefore regarded the small spores as necessary for impregnation. Esprit Fabre[††] carefully experimented on *Marsilea Fabri*. The separated large spores did not germinate; they did not even produce the stationary green papilla observed in *Salvinia* by Pietro Savi. Dr. C. Müller[‡‡] found that the large spores of *Pilularia* would not germinate when separate from the small ones.

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[*] Hist. de l'Acad. Roy. des Sc., 1739 and 1740.

[†] Micheli, Linnæus and Hedwig.

[‡] Biblioth. Italian, xx.

[§] Dis. de *Salv. nat.* &c., 1825.

[‖] Nova Acta xiv, and Cryptogam Gew., part 2, 1828.

[¶] De *Pilularia* diss. 1835.

[**] Ann. des Sci. Nat., 1837.

[††] Ann. des Sci. Nat., 1837.

[‡‡] Flora, 1840.

The development of the spores and the germination of the larger kind in *Pilularia* appear to have been first accurately described by Mr. Valentine,[*] in a paper read before the Linnæan Society in March, 1839. It is unnecessary to enter into the particulars of this paper, which gives accurate statements in most points, and mentions for the first time the occurrence of the cellular papilla upon the pro-embryo which has since been regarded as the "ovule," analogous to that found on the pro-embryo of the other vascular Cryptogams.

Dr. C. Müller's[†] essay appeared in 1840, and agrees in some points; but he appears to have mistaken the mode of origin of the pro-embryo. In 1843, Schleiden[‡] announced that he had observed a process of impregnation in *Pilularia*, in which the small spores acted the part of pollen-grains, producing tubes which entered into a cavity on the surface of the large spore or "ovule," and, in accordance with his views of impregnation in general, became the embryo.

The next paper on the subject was an essay published by Dr. Mettenius[§] in 1846, in which the anatomy and development of *Salvinia* is treated at length; that of *Pilularia* and *Marsilea* less perfectly. He did not observe the process of impregnation described by Schleiden, yet from the want of organic continuity between the embryo and the "ovule," he inclined to adopt the theory of fertilization propounded by Schleiden, both for the Phanerogamia and the Rhizocarpeæ, namely, that the end of the pollen-tube penetrated into the so-called ovule and became the embryo; nevertheless he had some doubts, since he could not reconcile the production of "pollen-tubes" from the small spores of *Salvinia* with the facts he had observed, and never saw the "tube" penetrate the "ovule" in *Pilularia.*

In 1846, Prof. Nägeli published some new and important observations on *Pilularia*,[‖] in which he stated that the observations of Schleiden were altogether incorrect, and that the bodies which that author had described as three or four "pollen-tubes," produced by the small spores and adherent to the summit of the large spore, were in fact parts of this, constituting a papilliform structure, forming a part of the pro-embryo developed by the large spore itself. Moreover he discovered a totally unexpected fact in regard to the small spore or "pollen grains." He found that these, without coming in contact with the large spores at all, became elongated by the inner coat protruding like a short pouch-like process through the outer. This contained starch-granules; and some he found burst and surrounded by starch-grains exactly

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[*] Linnæan Transactions, vol. xvii.

[†] Flora, 1840.

[‡] Grundz. der Wiss. Botanik, 1843.

[§] Beiträge zur Kenntniss der Rhizocarpeæ. Frankfort, 1846.

[‖] Zeitschrift für Wiss. Botanik. Heft 3, 4, 188, 1846.

like those inside the others; and in addition to these, minute cellules which seem to have been expelled from the small spores. In these cellules were developed spiral filaments exhibiting active movement, just like those of *Chara*, the Mosses, &c. These filaments finally make their way out and swim about freely in the water. They were constantly met with in the gelatinous mass in which the spores were enveloped.

In 1849, M. Hofmeister* published an essay on the higher Cryptogams already alluded to, and there briefly described his own critical observations, referring to the points of difference from his predecessors. His statements are as follows:—

"The publications of Mettenius and Nägeli, as also those of Schleiden himself, sufficiently show that the large spores of the Rhizocarpeæ (the organs called by Schleiden 'seed-buds' [ovules]) originate essentially in the same way as the spores of the Cryptogamia generally, and as the small spores of the Rhizocarpeæ ('pollen-grains' of Schleiden) in particular. One young spore in each *sporangium* becomes developed more rapidly than the others, and finally usurps the whole cavity. At the time when the spores are ripe, a large spore does not differ from a small one in any respect except in dimensions (the size of the organs allows of the structure of the outer secreted layer being very distinctly observed; in *Pilularia* five layers can be clearly detected). The large spore is a simple tough-walled cell filled with starch or oil-drops and albuminous matter, enclosed by a thick *exine*, which, at the point when the 'sister-spores' were in contact with the developed spore in the earlier stages, exhibits peculiar conditions of form, displaying, according to the generic differences, a splitting into thin lobes or a considerable thinning of the mass. Not the least trace of the cellular body (the pro-embryo, *papilla of the nucleus* of Schleiden) is to be seen at this point at the time when the spores are just ripe.

"After the ripe spores have lain a longer or shorter time in water, a process of cell-formation commences at that point of the spore, *within* the proper, internal spore-cell, whence results the formation of a cellular body occupying only a small portion of the internal cavity of the spore. The cells multiply rapidly, and break through the *exine*, appearing externally as the green cellular papilla called the '*keim-wulst*' by Bischoff, the 'papilla of the nucleus' by Schleiden. I see no ground why this should be named otherwise than as the *pro-embryo*. In *Pilularia* it is very soon seen, where the pro-embryo consists of only about thirty cells, completely enveloped in the *exine*, and where the only external evidence of its existence is a little protuberance,—that the pro-embryo consists of a large central cell surrounded by a simple

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[*] Botanische Zeitung, vol. vii, 1849; Botanical Gazette, vol. vii, 1850.

layer of smaller ones. The smaller cells covering the apex of this large cell, four in number, elongate into a papilla before the pro-embryo bursts through the *exine*, which splits regularly into twelve to sixteen teeth;—subsequently they become divided by horizontal walls, and then appear as the organ which Schleiden, and after him Mettenius, supposed to be 'pollen-tubes' produced from some of the small spores. These papilliform cells most certainly originate from the pro-embryo, a fact which takes away all material ground from Schleiden's theory.

"The four papilliform cells separate from each other and leave a passage leading to the large central cell. In this cell the young plant originates shortly after the smaller spores, which *never* produce 'pollen-tubes,' begin to emit the cellules containing spiral filaments discovered by Nägeli. I observed and dissected out an embryo consisting of only four cells. It completely filled the large central cell, and there was not the least trace of a pollen-tube attached to it.

"The organization of *Salvinia* is somewhat different from this. On every pro-embryo, several, as many as eight, cells of the outer surface of the cellular layer next but two to the obtuse triangular cellular body, acquire a considerable size, a spherical form, and become filled with protoplasm; the four cells covering each of these larger cells lose the greater part of their chlorophyll and separate from each other to leave a passage leading down to the large central cell. In this large cell the young plant originates. The number of these organs in *Salvinia* allows the possibility of the occurrence of poly-embryony in this genus; I observed two embryos on one pro-embryo in one case.

"It is out of the question to talk of a 'larger pollen-tube' in *Salvinia*. Mettenius has already shown that the structure of the small spores renders such a product from them impossible."

Dr. Mettenius's Essay on the Vascular Cryptogams,* already frequently referred to, confirms the preceding account in all essential points, some slight criticisms relating only to the structure of the coats of the spore; and it adds a description of the development of the 'ovules' in the pro-embryo of *Marsilea Fabri*, which agrees closely with that in *Pilularia*. Hofmeister† has recently announced the discovery of the production of cellules containing spiral filaments from the small spores in *Salvinia*, just as Nägeli saw them in *Pilularia*.

General Conclusions.

In the facts of which I have given confessedly a very imperfect *resumé* in the preceding pages, we have two important points to consider. In the first place, we have to determine how far

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* Beiträge zur Botanik. Heidelberg, 1850.

† Flora, 1850, p. 700 (in a note to a review of Mercklin's Essay on the Reproduction of Ferns).

they suffice to warrant the belief in the existence of a distinction of sexes in these families. In the second place, we have to endeavor to trace the analogies which exist between the different conditions presented by the supposed sexual organs in the different families. These considerations, if we adopt the hypothesis of sexuality, lead to some very interesting questions in reference to the process of reproduction generally.

In regard to the first question, that of the existence of two sexes and the necessity of a process of fertilization, we have several kinds of evidence.

1. The inferences to be deduced from the universality of the existence of two kinds of organs in connection with the reproductive process. We have seen that these exist in all the families at some period or other of the life of the representative of the species. In the Mosses and the Hepaticæ they occur in the fully developed plant. In the Ferns and Equisetaceæ they occur upon cellular structures of frondose character developed from all the spores, which frondose bodies or pro-embryos have an existence of some permanence, especially in the Equisetaceæ. In the Lycopodiaceæ, the Isoëtaceæ and Rhizocarpeæ, the pistillidia occur upon very transitory cellular structures produced from one kind of spore, the larger; while the smaller spores at once develop in their interior cellules containing moving spiral filaments, such as occur in the antheridia of the other families.

2. The inferences to be deduced from the observations on the development of those plants in which the two kinds of organs, occurring in distinct places, can be separated. Strong evidence has been brought forward that the diœcious Mosses, as they are called, do not produce sporangia when the pistillidia are kept apart from the antheridia by natural accident. The majority of observers state that the large spores of the Rhizocarpeæ do not germinate if the small spores are all removed from contact with them; a few counter-statements however do exist. Again, the majority of authors, and all the recent ones, state that only the large spores of the Lycopodiaceæ and Isoëtaceæ produce new plants; while some older writers believed that they had seen the small spores do so.

3. The direct observation of a process of fertilization, of which we have only testimony from two authors, Suminski and Mercklin, in reference to the Ferns alone; since the assertions of Schleiden in regard to the Rhizocarpeæ have been demonstrated by Nägeli, Hofmeister and Mettenius to have been based on very imperfect observation.

The circumstantial evidence furnished under the first head seems to me very strong, so much so that I am inclined to adopt the idea of sexuality on this ground as the legitimate provisional hypothesis arising out of our present knowledge, especially when supported so strongly as it is by the negative evidence indicated under the second head.

The positive evidence of the third head is certainly very insufficient as yet, considering the extreme delicacy of the investigation. Suminski's other observations on the details have been contested in many particulars; and Mercklin, the only other observer who asserts that he has seen the spiral filaments within the so-called ovules, describes the conditions differently, and states that he has only been able to observe them positively there three times. At the same time the difficulty of the investigation should make us hesitate in attaching too much weight to the failure of the other observers in tracing a process of fertilization; moreover it is quite possible that actual entry of the spiral filaments into the canal of the ovules or pistillidia is not always, if ever, necessary.

The facts before us, then, appear to me strong enough to warrant the adoption of the views propounded by the latest authors on this subject, and the acceptance of the hypothesis of sexuality in the Vascular Cryptogams as the most satisfactory explanation of the phenomena as yet observed. The question lies now much in the same condition as that of the sexuality of flowering plants before the actual contact of the pollen-tubes with the ovules had been satisfactorily demonstrated.

Further arguments may be adduced from grounds lying out of the preceding statements, viz. 1. The late discovery of two forms of organs in the Algæ, Lichens and Fungi, which, although imperfect at present, lead to the expectation that the analogues of the antheridia and pistillidia of the Mosses, so long known, will be found in all Cryptogamous plants. 2. The analogies between the processes of animal and vegetable reproduction which appear to be offered by these new views of the nature of the phenomena in the Vascular Cryptogams. To this last argument I shall merely allude, as it may be considered to lie beyond the special province of the vegetable physiologist; yet when we recollect the imperceptible character of the gradations of the lower forms of the two kingdoms, there seems far sounder ground than is allowed by Schleiden for arguing from apparent analogies between the phenomena occurring in the two great kingdoms of nature.

Under the second point of view mentioned above, the facts of structure may soon be disposed of, so far as the analogies of form are concerned; the antheridia of the Mosses, Hepaticæ, Ferns, and Equisetaceæ agree with the small spores of *Isoëtes*, *Selaginella*, *Pilularia*, and *Salvinia* in producing the cellules in which are developed the moving spiral filaments which constitute the essential character of the organs of the one kind; while the pistillidia of the Mosses and Hepaticæ agree with the so-called "ovules" of the Ferns, Equisetaceæ, Lycopodiaceæ, Isoëtaceæ, and Rhizocarpeæ, in general structure and in the presence of the central large cell from which the new form of structure originates.

The great differences depend on the position in time and space of the organs, in the different classes, and the nature of the immediate product of the so-called "embryo-sac," the large central cell of the pistillidia and "ovules."

In the Mosses and Hepaticæ the pistillidia occur upon the plant when the vegetative structure is perfect,—and the immediate product of the great cell is a sporangium. If a process of fertilization takes place here, we may regard the antheridia and pistillidia as analogues of the anthers and pistils of flowering plants; the sporangias of their fruits; or with Hofmeister we may regard the phenomena as an instance of an "alteration of generations," where the pistillidium would be looked upon as an ovule, producing (in the sporangium) a new individual of totally different character from that developed from the spore (the leafy moss plant in the usual acceptation of the term).

In the Ferns and Equistaceæ, we find the spores producing a frondose structure of definite form, upon which are developed antheridia and pistillidia or "ovules." Here then we seem to have one generation complete, and the new development from the pistillidium or "ovule" appears in a totally new form, producing stem and leaves which have a distinct individual form and existence, and produce the spores after a long period upon temporary parts of the structure, on the leaves; and by no means cease to exist when those are matured. Here we seem to have a real "alternation of generations," and Hofmeister compares the whole permanent plant of the Fern or *Equisetum* to the sporangium of the Mosses and Hepaticæ. In all the other families, the Lycopodiaceæ, Isoëtaceæ, the Rhizocarpeæ, the pro-embryo is a very transitory production, and is developed from a different spore from the spiral filaments. This pro-embryo is clearly analogous to that of the Ferns and Equisetaceæ; and if the existence of sexes be a fact, we have here a dœcious condition as contrasted with a monœcious condition in the two last-named families. Hofmeister here again assumes that the pro-embryo developed from the large spore is an intermediate generation between the two perfect forms of the plant.

It is rather difficult to decide upon the real analogies of these structures with those of the flowering plants. The resemblance of structure is so close between the pistillidia of the Mosses and Hepaticæ, and the "ovules" of the other Vascular Cryptogams, that they must be regarded as analogues, and then the former could not well be conceived to be analogous to the pistils of flowering plants, but rather to ovules; if this be the case, the sporangium must be considered the analogue of the perfect plant in the Fern, &c., and the leafy stem as the analogue of the pro-embryo of the Ferns, &c. The pistillidium of the Mosses can indeed hardly be regarded as analogous to the fruit of a flowering plant, as in that case the spores would be ovules produced long after fertilization; and on the other hand, if we consider the pistillidia of the Moss as an ovule, which it might be, analogous to that of the Coniferæ,—in which a large number of embryonal vesicles or rudiments of embryos are produced after fertilization on the branched extremities of the suspensors,—then we seem to lose the analogy between the product of the pistillidium of the Moss and that of the ovule of the Fern, unless we would regard the entire plant of a perfect Fern as analogous to the ovule of a Conifer.

Perhaps the time has hardly come for us to arrive at any conclusion on these points. The phenomena in the Ferns and Equisetaceæ, as well as in the Rhizocarpeæ, Lycopodiaceæ, and Isoëtaceæ less strikingly, seem to present a series of conditions analogous to those which have been described under the name of "alternation of generations" in the animal kingdom, and seeing the resemblance which the pistillidia of the Mosses have to the ovules of the other families, we can hardly help extending the same views to them; in which case we should have the remarkable phenomenon of a compound organism, in which a new individual forming a second generation, developed after a process of fertilization, remains attached organically to the parent, from which it differs totally in all anatomical and physiological characters. It is almost needless to advert to the essential difference between such a case and that of the occurrence of flower-buds and leaf-buds on one stem in the Phanerogamia, as parts of a single plant, yet possessing a certain amount of independent individuality. These are produced from each other by simple extension, a kind of gemmation; while the Moss capsule, if the sexual theory be correct, is the result of a true *reproductive* process.*

In conclusion, I may remark, that these anomalous conditions lose their remarkable character to a great extent if we refuse to accept the evidence of sexuality which has been brought forward here. If the structures are all products of mere extension or gemmation, the analogies which have been supposed to exist between them and the organs of flowering plants all fall to the ground. But believing that the hypothesis of sexuality is based on solid grounds, I am by no means inclined to allow the difficulty of the explanation of these relations to be urged as a valid argument against their existence, and I trust that this imperfect report may be the means of attracting new investigators to a sub-

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* Moreover we have analogy to the increase by buds in the *innovations* by which the leafy stems of the Mosses are multiplied, both in the earliest condition, where a number of stems are developed from the byssoid mass produced by the spore, and afterwards by gemmæ on the stems and leaves, as in the Liverworts also. The byssoid mass produced by the Moss-spore has usually been called the *pro-embryo*, but it is evidently not analogous to the bodies termed pro-embryos in the Ferns, Lycopodiaceæ, &c., &c. It would almost seem to constitute a third member of a series of generations.

ject which presents so many points of interest and importance.—*July 3rd*, 1851.

Postscript.—Since the above Report has been in print, Dr. W. Hofmeister has published his promised work upon the higher Cryptogams,* which contains an elaborate series of researches upon this subject. He there confirms all his previous statements, and all the essential particulars given by Suminski, Nägeli, Mettenius, &c., excepting the *facts* of the impregnation by means of the spiral filaments or spermatozoids, which however he considers it warrantable to *assume*. His speculations as to the relation of the Conifers to the Lycopodiaceæ, as shown by the development of the embryo, are very interesting. We can only claim space to indicate the general results of his work as given in the concluding summary :—"The comparison of the course of development of the Mosses and Liverworts on the one hand, with the Ferns, Equisetaceæ, Rhizocarpeæ and Lycopodiaceæ on the other, reveals the most complete agreement between the development of the fruit of the former and the development of the embryo of the others. The archegonium of the Mosses, the organ within which the rudiment of its fruit is formed, resembles perfectly in structure the archegonium of the Filicoids, (in the widest sense,) that part of the prothallium in the interior of which the embryo of the frondescent plant originates. In the two great groups of the higher Cryptogams, one large central cell originating free in the archegonium, gives origin by repeated subdivision to the fruit in the Mosses, and to the leafy plant in the Filicoids. In neither of them does the subdivision of this cell go on, in both does the archegonium become abortive, if spermatic filaments do not reach it at the epoch when it bursts open at the apex.

"Mosses and Filicoids thus afford one of the most striking examples of a regular alternation of two generations widely different in their organization. The first of these, produced by the germinating spore, develops antheridia and archegonia, sometimes few, sometimes many. In the central cell of the archegonium, in consequence of a fertilization through the spermatozoids emitted from the antheridia, becomes developed the second generation, destined to produce spores, which are always formed in a number much greater than that of the rudimentary fruits of the first generation.

"In the Mosses the vegetative life is exclusively committed to the first, the production of fruit to the second generation. Only the leafy stem possesses roots; the spore-producing generation

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* Vergleichende Untersuchungen der Keimung, Entfaltung und Fruchtbildung höherer Kryptogamen (Moose, Farrn, Equisetaceen, Rhizocarpeen und Lycopodiaceen) und der Samenbildung der Coniferen. 1851, Leipsic, Hofmeister, 4to, pp. 180, tt. 33.

draws its sustenance from the foregoing. The fruit is usually of shorter duration than the leaf-bearing plant. In the Filicoids the opposite condition obtains. It is true the prothallia send out capillary rootlets; those of the Polypodiaceæ and Equisetaceæ under all circumstances, those of the Rhizocarpeæ and Selaginellæ frequently. But the prothallium has a much briefer existence than the frondescent plant which in most cases must vegetate for several years before it comes to bear fruit. Yet the contrast is not so strong as it appears to be at first sight. The seemingly unlimited duration of the leaf-bearing moss-plant depends upon constant renovation (*verjüngung*). Phenomena essentially similar occur in proliferous prothallia of the Polypodiaceæ and Equisetaceæ. The structure of the lowest Mosses (*Anthoceros*, *Pellia*) is less complex, and the duration of the fruit-bearing shoots is little longer than that of the fruit itself. On the other hand, the ramification of the prothallium of the Equisetaceæ is exceedingly complicated; its duration is even equal to that of a single shoot.

"It is a circumstance worthy of notice, that in the second generation of Mosses, as of the Filicoids, destined to produce spores, more complex thickenings of the cell-walls regularly occur (teeth of the peristome of Mosses, wall of capsule and elaters of Liverworts, vessels of Filicoids, &c.,) while in the first generation, springing from the spores, such structures are found only rarely and as exceptions.

"The manner in which the second generation arises from the first, varies much more in the Filicoids than in the Mosses. The Polypodiaceæ and Equisetaceæ are hermaphrodite; the Rhizocarpeæ and Selaginellæ monœcious. All the Filicoids agree in the fact that the first axis of their embryo possesses but a very limited longitudinal development; that it is an axis of the second rank which breaks through the prothallium and becomes the main axis; further, in the end of the axis of the first rank never becoming elongated in the direction opposite to the summit. All Filicoids are devoid of a tap-root, and possess only adventitious roots.

"In more than one respect does the course of development of the embryo of the Conifers stand intermediately between those of the higher Cryptogams and the Phanerogams. Like the primary parent-cell of the spores of the Rhizocarpeæ and Selaginellæ, the embryo-sac is an axile cell of the shoot, which in the former is converted into a sporangium, in the latter into an ovule. In the Conifers the embryo-sac also very early becomes detached from the cellular tissue surrounding it. The filling-up of the embryo-sac with the albumen may be compared with the origin of the prothallium in the Rhizocarpeæ and Selaginella. The structure of the 'corpuscula' bears the most striking resemblance to that of the archegonia of *Salvinia*, still more to that of the Selaginellæ.

If we leave out of view the different nature of the impregnation, in the Rhizocarpeæ and Selaginellæ by free-swimming spermatic filaments, in the Coniferæ by a pollen-tube (which *perhaps* develops spermatic filaments in its interior), the metamorphosis of the embryonal vesicle into the primary parent-cell of the new plant in the Conifers and Filicoids is solely distinguished, by the latter possessing only a single embryonal vesicle which completely fills the cavity of the central cell of the archegonium, while the former exhibits very numerous embryonal vesicles swimming in it, of which only one pressed into the lower end of the 'corpusculum' becomes impregnated. The embryo-sac of the Conifers may be regarded as a spore which remains enclosed in its sporangium; the prothallium which it forms never comes to light. The fertilizing matter must make a way for itself through the tissue of the sporangium, to reach the archegonia of this protallium.

"Two of the phenomena which led me to compare the embryo-sac of the Conifers with the large spores of the higher Cryptogams, are common also to the embryo-sac of the Phanerogams: the origin from an axile cell of the shoot, and the independence of the surrounding cellular tissue (so striking, for example, in the Rhinanthaceæ, through the independent growth of the embryo-sac). By their pollen-grains producing tubes the Conifers are closely connected with the Phanerogams, from which they differ so much in the course of development of their embryo-sac and the embryonal vesicles. The separation of the prothallium of the Conifers into a number of independent spensors, is a phenomenon of a most peculiar kind, having no analogue throughout the vegetable kingdom."—(*Loc. cit.* pp. 139–41.)—A. H. December 16, 1851.

Art. V.—*Review of Phillips's Mineralogy by Brooke and Miller.**

This new edition of Phillips's Mineralogy has for several years past been looked for with great interest. The name of Phillips is deservedly distinguished in British mineralogical science; and the addition of the labors of Brooke and Miller has seemed to promise a work of unusual merit. The copartnership proves however to be one in which the older author has no concern or rightful title; for scarcely a trace of the original labors of Phillips

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* An Elementary Introduction to Mineralogy, by the late Wm. Phillips. New edition, with extensive alterations and additions, by H. J. Brooke, F.R.S., F.G.S., and W. H. Miller, M.A., F.R.S., F.G.S., Professor Min. Univ. of Cambridge. 700 pp., 12mo. London, 1852, Longman, Brown, Green and Longman.

remains: and even his figures of crystals and measurements, in which department he was especially eminent, have disappeared. The work has certainly lost in value by this rejection of all that Phillips could call his own, while at the same time it has gained a new importance from the able crystallographic labors of its present authors. There was also some ground for supposing that the work would be especially adapted for this continent as well as the other, in the fact that an edition of Phillips had been issued here by Alger. But Mr. Alger's name and book are hardly noticed through the volume.

The work has many peculiarities and certain defects, the mention of which is of some interest to American mineralogists and to the science. We propose therefore to run through its pages, briefly touching upon such points as will exhibit its character in a just light.

The first 50 pages are devoted to Crystallography. The system adopted is that of Prof. Miller. The subject is presented in an abstract mathematical form, with few explanations of the general principles and laws for the occurrence of secondary planes, and without any illustration of the distortions to which crystals are subject. The names adopted for the six systems of crystallization, are the *cubic*, *pyramidal*, *rhombohedral*, *prismatic*, *oblique*, and *anorthic*. Figures are given in the descriptive part of the work, illustrating the crystallization of the species. These figures, however, with rare exceptions, are simply plans, or views in the direction of one of the axes, usually the vertical. They are drawn with precision and are excellent as far as they go. But they are not portraitures of crystals, and give no sufficient idea of the prevailing forms. Augite, zircon, anatase, for example, have each a crystallographic physiognomy easily recognized. But from these plans, the student has no way of arriving at a knowledge of this physiognomy or of ascertaining the actual character of a crystal, since the length cannot by any powers of conception or study be deduced. An octahedron thus represented is not distinguishable from an elongated prism with pyramidal terminations, nor a scalenohedron or a rhombohedron from a terminated six-sided prism. The figures under calc spar are examples to the point.

Besides these plans, which are seldom more than two to a species, there is a large circle marked with dots, which exhibits in an ingenious manner the positions of the faces of all known crystals of the species. These circles, however, hardly convey any information not implied in the mathematical symbols of the planes, which to some extent are also given. There is, besides, a system of letters, not for the figures, but for designating and describing secondary forms. For example, under Realgar (p. 177) the occurring combinations of secondary planes are described as follows: *cm, cmrl, xrml, crmle, crmleb, crmltzab, nrceqfmwlvab, xnezucrfmwvab.* A key to these letters is given in the earlier part of the work. Thus there are three modes of designating planes; one, by numbers, corresponding mainly in form, with Weiss's system, omitting the ratio sign, as 111, 012, 212, &c.; another, the system of letters, just alluded to; and the third, the dots. The first strikes us as the best, and, if slightly modified, as the only one required or needed. The others are perplexing to the student.

The authors have added very much to our knowledge of the crystals of species by their measurements and calculations, and in this, the great merit and value of the work mainly consist. With each species, a large number of angles is mentioned; these angles are those between normals (perpendiculars) to the faces, instead of those between the faces themselves.

The chapters on Refraction and Pleochroism are well drawn up, and the others on the Physical characters, though brief, are sufficient for the purposes of the Mineralogist.

Under the head of Chemical Constitution, a classification of the elements is given, in which, we judge, no attempt was made to present a view of the true chemical relations of the elements.

The idea that silica contains two of oxygen ($Si\,O^2$) instead of three ($Si\,O^3$), is adopted throughout the work in its chemical formulas, a view proposed a few years since by Gmelin, but generally rejected since the researches of Kopp. The authors also have made alumina to consist of 1 of aluminium to 3 of oxygen ($Al\,O^3$), while the peroxyd of iron and allied compounds have the ratio 2 : 3, ($Fe^2\,O^3$, $Cr^2\,O^3$), as is seen in the table on page 79, and afterwards through the descriptions of the species. This view of alumina is adopted by Rammelsberg in his recent publications, but not that of silica.

In the chapter on *Isomorphism*, a table, extracted principally, as stated, from Frankenheim's "System der Krystalle," presents a list of various isomorphous groups. This table might have been much extended by the results of later researches. For example, the isomorphism of calc spar, nitrate of soda, and dark red silver ore, and that of arragonite, nitrate of potash, and Bournonite, brought out by Rose are not recognized; neither the observations of Rammelsberg or Scheerer. A paper in this Journal, published in 1850,* besides others of more recent date, might have afforded additional facts bearing upon a branch of Isomorphism not alluded to.

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* Vol. ix, 2nd Ser., p. 220.

A good chapter on the Chemical reactions of Minerals occupies from pages 85 to 100.

The descriptive part of the Treatise commences with the "*Metalloids*," sulphur, selenium, carbon; then follow the *Metals;* next the *Tellurides;* then in order the *Antimonides—Arsenides—Selenides—Sulphides—Oxyds, earths and acids—Hydrous oxyds, earths and acids—Silicates—Hydrous silicates—Tantalates, niobates, scheelates, molybdates—Arseniates, phosphates—Hydrous arseniates, phosphates—Sulphates—Hydrous sulphates—Chromates—Vanadiates—Sulphates with Carbonates—Carbonates—Hydrous carbonates—Nitrates—Borates—Fluorides, Chlorides, Bromides, Iodides—Resins, Coal.*

The descriptions are given with precision and sufficient brevity. The lists of localities are mostly mere lists of names, with seldom any mention of the associations of the species. As is natural, American localities are given less definitely than those of Britain or Europe, when not altogether forgotten. Of *Rutile*, it is said that it occurs in *North America*, certainly an important fact to the mineralogists of England, as well as to those of North America itself.

The analyses introduced are rather numerous, but no references are added to the Journals in which they were originally published; neither is there more than a single chemical formula given, although a species may be of doubtful composition, or, as in the case of Scapolite, it may actually include several compounds.

Along with the names of species in the heading preceding the descriptions, the names of certain mineralogists are usually mentioned. But it is remarkable that the old rule of giving an author credit for his work is set aside. Since the enactments of certain laws relating to nomenclature by the British Association, it has been supposed that in Britain at least, there was a high sense of delicacy on this point. But the authorities mentioned by Messrs. Brooke and Miller are often only the names of certain authors of Treatises, to the exclusion of those of original observers. Turning to *Gibbsite*, we find with some surprise, that the species is attributed to Phillips, and *Gibbsit* to Mohs, Hausmann, and Haidinger, and our friend Dr. Torrey is forgotten. *Cancrinite* of Rose is in the same way attributed to Hausmann; *Schorlomite* of Shepard to Rammelsberg; *Diaspore* is followed by "Phillips, Haüy," instead of "Haüy, Phillips," in their proper order; *Hornblende* is attended by the name of Phillips alone; *Apatite* is attributed to Phillips, and then *Apatit* to Hausmann, Haidinger, again. Such a use of names is calculated to mislead, unless understood to mean simply that this or that author has the name in his book, which is all that the authors could have intended, and which principle should have been somewhere announced.

Some species that were already abundantly supplied with names have been here supplied anew. Thus Copper pyrites, called also Chalcopyrite by Haidinger, passes under the new name *Towanite.* No reason is given for the change. Chalcolite (or Lime-Uranite) is named *Torberite.* Uranite (or Copper-Uranite) is *Autunite.* Atacamite or chlorid of copper appears as *Remolinite;* Azurite or Blue Malachite as *Chessylite.* These will suffice as examples.

Again, some German names are adopted in their German dress, and look queer enough in an English work. Such are *Antimonsilber*, in place of Antimonsilver, or Antimonial Silver; *Kupfernickel*, instead of Copper-Nickel, the thing in plain English. Names consisting of two words are repudiated by some mineralogists, and various are the shifts to avoid them:—just the reverse of the fact in other branches of Natural Science. Hence it is, apparently, that the word *Kupfernickel*, in which the two parts can be written together without a hyphen, is deemed preferable to *Copper-nickel.* It is probably on the same principle that Red Zinc Ore must give way, according to our authors, for *Spartalite;* and Copper Glance (from the German Kupferglanz) or Vitreous Copper, for *Redruthite*, a name, by the way, proposed by Nicol in his recent valuable work, although not so acknowledged in this edition of Phillips. So Magnetic Pyrites is made to yield to *Pyrrhotine;* Spathic Iron to *Chalybite;* Schiller Spar to *Bastite;* Specular Iron to *Hematite*, a word of most ambiguous signification in the science. For ourselves, we see no reason for this abhorrence of such names.

Eisennickelkies is another example of a foreign name accepted by our authors; and how is it better than iron-nickel-pyrites, which it signifies? or *Porzellanspath* than Porcelain-spar, a name already in use? Let the reader examine these words and pronounce each syllable considerately, and then judge how far science, sense, or taste, is benefitted by retaining in an English book the German orthography. Quite as good reason might be found, for a general substitution in Britain of the German for the English language. So also *Feuerblende* (p. 216); which the mineralogist, without a knowledge of German, would be likely to pronounce *Fewerblende*, while *Fireblende* represents closely, in fact, its pronunciation as well as meaning. Even Pyrites has lost an *s*, (after Haidinger,) and it stands *Pyrite*, a name hardly distinguishable from Pyrrhite, the designation of another species. The whims of authors thus tend to keep the synonymy of Mineralogy in a state of constant ferment.

The work of Messrs. Brooke and Miller has also its deficiencies. We should at least expect to find a full list of known species and known varieties, and also of current synonyms. The deficiency in the latter might be extensively illustrated. Thus

Heavy spar is not mentioned as a synonym of Baryte, (another new name,) and of course Heavy spar is not in the Index; *Bromlite* is not given as a synonym of Alstonite; *yenite* of Ilvaite; *manganese spar* of Rhodonite, etc.

There are also omissions of species and facts that are somewhat difficult of explanation. It will be of most interest to American mineralogists to learn of those that pertain to American minerals.

The species *Gibbsite*, found at Richmond, Mass., was first correctly analyzed and described, years ago, by Dr. Torrey. Hermann recently analyzed certain specimens from Richmond and reported their containing a large amount of phosphoric acid. This led to some careful analyses by Silliman, Jr., who proved that Dr. Torrey was right, no phosphoric acid, or but a trace, being detected. These results are published in Dana's Mineralogy, and in this Journal, volume vii, p. 411, (1849). Brooke and Miller mention only the analyses of Hermann, not even intimating that any different view is held by others, although Hermann's own results vary in the phosphoric acid from 37·6 to 11·9 per cent! Moreover, to add to the confusion, the Gibbsite locality, Richmond, is referred to as a locality of Hydrargillite as well as of Gibbsite, although it is well known that but one of these species occurs there.

Emerylite of Dr. J. Lawrence Smith has been found within the past three or four years to be a very common mineral, occurring with corundum in Asia Minor and Siberia, as well as in the United States, in North Carolina and Pennsylvania. There have been *six* analyses of American specimens by three different chemists;* also *eight* by Dr. Smith of the Asia Minor mineral, and *one*, by the same chemist, of a Siberian specimen. Dr. Smith's analyses are published in this Journal, Jan., 1851. All agree very closely. The authors of this new edition of Phillips throw the species into their Appendix, give a single analyses, and mention only the Pennsylvania and Asia Minor localities. But this is not all.

Early in 1851, (May,) Hermann published in Erdmann's Jour. für Prakt. Chemie,† a paper on Mica and Cordierite, in which he gives a new analysis of Margarite,—a mineral till then but imperfectly investigated. Hermann's result (unknown to himself, at the time) proves the identity of emerylite and margarite (a fact long before suspected by Dr. Smith and other American mineralogists, and recently partly ascertained by an unfinished analysis by Mr. G. J. Brush). The work before us has only the old erroneous analysis of Margarite, and does not recognize this new fact respecting Emerylite.

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* See Dana's Mineralogy, 3d edition, 1850, p. 362.

† Vol. liii, p. 1.

Corundellite is another Appendix species; and a little more attention to published results would have banished it altogether. Both in this Journal two years since, and in Dana's Mineralogy, its identity with Emerylite is announced and a new analysis published. *Euphyllite* is in the same Appendix; but instead of giving the later results, published two years since in the works just alluded to—both certainly accessible works to the scientific enquirer—only the first incorrect analysis is introduced. The new analyses were made in the same laboratory with the first, an error in the early results having been suspected.

Warwickite, another Appendix species, is published with an analysis by Mr. T. S. Hunt, made in 1846, and no notice is taken of his new results published in this Journal in May, 1851, (xi, 352,) where the author gives a very different composition as to the proportions of the ingredients, and shows that the crystals before examined, although of the prevailing kind, had undergone alteration.

The greater part of *American* species are black-balled or have a place in the Appendix. The following are among the latter. *Boltonite*, *Danburite*, *Emerylite*, *Euphyllite*, *Warwickite*, *Liebigite*, *Emerald Nickel*, which are believed to be well established species, besides also others that are less well understood. Other species are rejected without any mention even among synonyms. Such are *Pennite*, *Phyllite*, *Williamsite*, *Microlite*, *Vermiculite*, *Chesterlite*, *Melanolite*, *Tungstic Ochre*, *Clinochlore*, *Melaconite*, *Dysyntribite*, *Rutherfordite*, *Paracolumbite*, *Houghite*, *Marasmolite*, *Calyptolite*, *Eumanite*, *Corundophilite*, *Ozarkite*, *Lederite*, *Medjidite.* Such a sweeping destruction of the enemy is certainly a great feat in Mineralogical tactics. We believe however that the authors have misjudged with regard to their readers, even supposing the species bad, which is undoubtedly true of several of them. The reference of the name of a bad species to the species to which it belongs, is conveying information which mineralogists value. A total rejection of published species and facts, which the authors have had no opportunity personally to study, does not show discrimination, mineralogical science, or an appreciation of the wants of mineralogists either in Europe, Britain, or America.

Again we observe that the important results of Dr. J. Lawrence Smith respecting Corundum, a paper read before the Academy of Sciences at Paris and published in this Journal (January, 1851,) are unnoticed. The species Phlogopite is not mentioned, nor the name alluded to. It is evidently referred to the species "Mica," by which is meant that kind of Mica sometimes called Oblique mica, and latterly by Dana, *Muscovite*, a name not recognized by Messrs. Brooke and Miller, nor admitted among synonyms.

We might pursue farther the list of delinquencies and extend it also to foreign species. As to the latter, there is less reason for complaint, although the work contains very little of what appeared in Europe in 1851. With regard to the former we think that American mineralogists have already been sufficiently amused and will appreciate their obligations to the authors, without more details. The book was probably intended for a certain class of English readers that do not consider American rocks or science within the range of British interests, and viewed in this light, its errors or deficiencies, are not more perhaps than were to be expected.

Art. VI.—*Description of the interior of the Cranium and of the form of the Brain of Mastodon giganteus;* by Jeffries Wyman, M.D.

The external configuration of the cranium of the Mastodon has been described by so many naturalists, especially by Cuvier, De Blainville, Godman, Hayes, Owen, and more recently by Warren, that little remains to be added to its descriptive anatomy. Its internal structure has however attracted but little notice comparatively, and in all probability but few instances, favorable for observation have occurred, the crania of Mastodons having been generally looked upon as too rare and valuable to warrant the risk of making sections or the necessary dismemberment of parts. In the collection of Mastodon bones discovered in Warren Co., New Jersey, in 1845, and now belonging to Harvard College, is the section of a cranium made under the direction of Dr. Warren and noticed in his recent memoir* on this extinct animal. From the perfect preservation of the bones and the care with which the section has been accomplished, an unusually good opportunity is afforded for studying its internal structure. In the memoir just referred to, Dr. Warren has for the first time given the diameters of the cranial cavity and described the fossæ in the base of the skull; the vast development of the diploic cells, and some of the foramina for the transmission of nerves, especially the foramen ovale, and Vidian canal, are also noticed. In plate 17 of his memoir is an excellent representation of the section of the cranium and face. The individual to which the skull above referred to belonged was obviously immature, as the ossification of some of the bones is not yet quite complete. The molar teeth are two in number on each side in each jaw and have each three ridges,

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* The Mastodon Giganteus of North America; by John C. Warren, M.D. Boston, 1852.

and were probably the third and the fourth of the dental series —the empty socket in front corresponding in size with the second two-ridged tooth.

Among the anatomical points of interest which have not as yet been especially described, are the number and proportional size of the foramina in the base of the skull; and the form of the brain as indicated by the configuration of the cranial cavity.

Olfactory foramina.—The cribriform plate on either side of the median lines is of a pyriform shape; it is about two and six-eighths inches in length by one and six-eighths in breadth, and is perforated by a large number of minute holes for the transmission of the filaments of the olfactory nerves. Of these openings one hundred and seventy-five were counted on one side. An opening larger than the rest exists at the upper part and serves for the exit of the nasal branch of the fifth pair of nerves.

The *Optic foramen* is vertically depressed having an elongated oval form; but as the optic canal recedes from the cranial cavity it becomes more nearly cylindrical, having a diameter of about three-sixteenths of an inch; the canal is directed upwards for the distance of seven inches when it reaches the orbit in the bottom of a deep channel.

The *Foramen lacerum of the orbit* is quite small, lies concealed beneath the anterior clinoid process, and is so much out of view that it would easily escape notice; it enters the orbit in the same channel with the optic nerve, but some distance below it.

In the cranium of an adult African elephant belonging to the Boston Society of Natural History, and which has served for the comparisons given in this notice, the foramen lacerum is more exposed within the cranium, and its outer opening is separated only by a thin septum of bone from that of the optic nerve—the canal for this last being much shorter than in the Mastodon.

The *Foramen rotundum* which transmits the second branch of the trigeminus nerve, is about one half of an inch in diameter, and occupies very nearly the position of the foramen lacerum of the orbit: in other animals it is only separated from this last by a thin bridge of bone; and this even no longer exists in some Ruminants, so that in these the foramen lacerum and rotundum are wholly blended.

The *Foramen ovale* measures an inch and a quarter in length and half an inch in breadth, but is partially divided, by slight projections of bone on each side, into a double opening. It is formed mainly by the edge of the great wing of the sphenoid, but its circumference posteriorly is completed by the petrous bone. The inner part of this foramen transmits the third branch of the trigeminus, while the outer portion is continuous with a channel in the cranial walls which lodges one of the meningeal vessels and corresponds with the foramen spinale of human anatomy.

In the African elephant the separation is carried still farther, the ridges of bone on opposite sides approaching very near to each other.

The *Carotid foramen* is situated behind the petrous bone, but is formed equally (when seen from below) by an indentation into the petrous and basilar bones; it is at first of an oval form, its long diameter being three-fourths of an inch, but soon becomes round and diminishes to a half of an inch; as it ascends vertically, it becomes more completely imbedded in the petrous bone, and as it enters the cranial cavity as seen from within, it is wholly contained in it; at this point it becomes continuous with a groove, which runs forwards on the sides of the sella turcica and terminates just within the anterior clinoid process. From the carotid canal a small opening transmits probably a meningeal vessel.

In both the African and Asiatic elephants this foramen exists and has a similar connection with a groove on each side of the sella turcica; in the former species it is wholly imbedded at its commencement in the petrous bone. This foramen is not mentioned by Cuvier, neither in his Ossemens Fossiles nor in his Anatomie Comparée; he describes the foramen ovale and that which transmits the carotid artery as forming one opening.* As stated above, the foramen spinale and foramen ovale are united together, but the first obviously serves only to transmit meningeal vessels.

The *Internal Auditory* foramen is much depressed and forms a fissure on the upper surface of the petrous bone.

Between the petrous bone and the basilar portion of the occiput, more external than the carotid foramen, is a fissure three inches in length, which serves to transmit the hypoglossus nerve, and is therefore the representative of the anterior *Condyloid foramen;* the external part of the same fissure is more narrow and is continuous with the lateral sinuses, and is in consequence to be regarded as the jugular fossa, though the jugular vein must become very much flattened in order to escape from the cranial cavity.

The *Stylo-mastoid foramen* is one-fourth of an inch in diameter.

The *Eustachian tube* enters the extremity of the petrous bone which last is prolonged into a spine. The *Vidian canal* is of great size, perforates the pterygoid process near the base, and is of an oval form and has a diameter of about three-fourths of an inch; the posterior orifice is in close proximity to the foramen ovale and the anterior to the foramen rotundum, which it nearly

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* Lecons d'Anat. Comp. Tome ii.

equals in size. The vidian canal it would seem contained something else than the vidian nerve, its size being wholly out of proportion to a filament comparatively so small. The *foramen incisivum* is much smaller than in Elephants, and is prolonged as in them into a canal which in the Mastodon measures ten inches in length.

The *foramen magnum* is nearly oval, being three inches in its transverse and two and a half in its vertical diameter.

The openings between the nasal fossæ and the diploic cells are very much larger than in the African elephant, and establish a free communication between these cells and the nasal orifices as far back as the occiput.

Leaving out of view other resemblances between the skeletons of Mastodons and Elephants, an examination of the bones of the face, especially those in the neighborhood of the nasal openings, would afford satisfactory evidence that Mastodons like the Elephants were provided with a nose elongated into a proboscis. Other evidence equally conclusive is found in a comparison of some of the foramina in the base of the skull of these two genera. In Elephants the existence of a trunk, gives rise to the necessity for a corresponding development of the motor and sensitive nerves of the face and these in turn to a proportional enlargement of the openings for their exit from the cranial cavity. The foramen rotundum and foramen lacerum transmit the sensitive nerves, branches of the trigeminus, and the stylo-mastoid foramen transmits the *portio dura* or motory nerve—and the two supply the necessary filaments to the muscles and skin. In both Mastodon and Elephant these foramina present similar proportional sizes—but in neither is the stylomastoid foramen which transmits the motory nerve or *portio dura,* as largely developed as the foramen rotundum—the latter having a diameter of a half of an inch in the Mastodon and of seven-eighths in the Elephant, while the latter does not exceed one-fourth of an inch in either. Cuvier describes the great size of the orbitar and superior maxillary branches of the trigeminus and of the portio dura in Elephants,* and more recently Mayer has more fully described and figured the same nerves, from a recent dissection of the parts.† The complete correspondence of these foramina in Mastodon and Elephant, would have enabled the comparative anatomist to determine the probable existence of a trunk in the former, even if the bones of the base of the skull only had been brought to light, the rest of the skeleton being unknown.

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* Lecons d'Anat. Comp. T. iii, pp. 199, 218. Paris, 1845.

† Beiträge zur Anatomie des Elephanten und der übrigen Pachydermen, von Dr. C. Mayer Nov. Act. Nat. Curios. T. xx, p. 1. 1847.

There is no peculiarity of the interior of the cranium of the Mastodon which more forcibly presses itself upon the notice of the comparative anatomist than its form; in this we have revealed to us the general outline and some of the details of the surface of the brain of which the cranial walls are on an accurate mould; and in this too we have additional means of making comparisons between the genera of Mastodon and Elephant and of determining another important element in their affinity.

The following measurements vary but little from those given by Dr. Warren in his memoir already cited.*

	Inches.
Greatest length of cranial cavity on median line from crista galli, to inner edge of foramen magnum,	$9\frac{3}{8}$
Greatest length from anterior part of olfactory fossa to edge of foramen magnum, - - -	10
Greatest height on median line, - - -	$5\frac{1}{4}$
Transverse diameter at posterior edge of orbitar fossa,	$7\frac{1}{8}$
Transverse diameter at anterior edge of occipital fossa,	$5\frac{7}{8}$
Transverse diameter through the centre of middle fossa,	$10\frac{4}{8}$

As however the cranium under consideration belonged to an immature Mastodon, but little of moment was deduced from its measurements or capacity merely. It is to the form of the whole and of its subdivisions that the principal interest attaches —and these next present themselves for description.

The *Olfactory lobes* are quite large in both the Mastodon and Elephant, when compared with the sensitive surface over which they preside, the index of this last being the turbinated portion of the ethmoid bone. The olfactory fossa in Mastodon is of a pyriform shape $2\frac{6}{8}$ inches long by $1\frac{6}{8}$ in the broadest part, and is several times longer in actual extent than the corresponding fossa in the ox or the horse; in the former the fossa measuring $1\frac{1}{8}$ inch by $\frac{6}{8}$th of an inch. On the other hand the sensitive surface of both these last mentioned animals is actually much longer than the corresponding ones of either the Mastodon or Elephant, as shown by the greater development of the ethmoid and lower turbinated bone. The position of the olfactory lobes is beneath the anterior lobes of the brain projecting forwards enough to be just visible when the brain is viewed from above, and as in the Elephant it resembles the situation of these parts in man. In the ox and other Ruminants, as well as in most Pachyderms on the contrary, these lobes are placed directly in front.

The *Cerebral hemispheres*, as an inspection of the accompanying figures, 1 and 2, will at once indicate, are the parts of all others which present the most characteristic feature of the encephalon. The anterior lobes are contracted to a most extraordinary degree, each having the form of a conical mass with the

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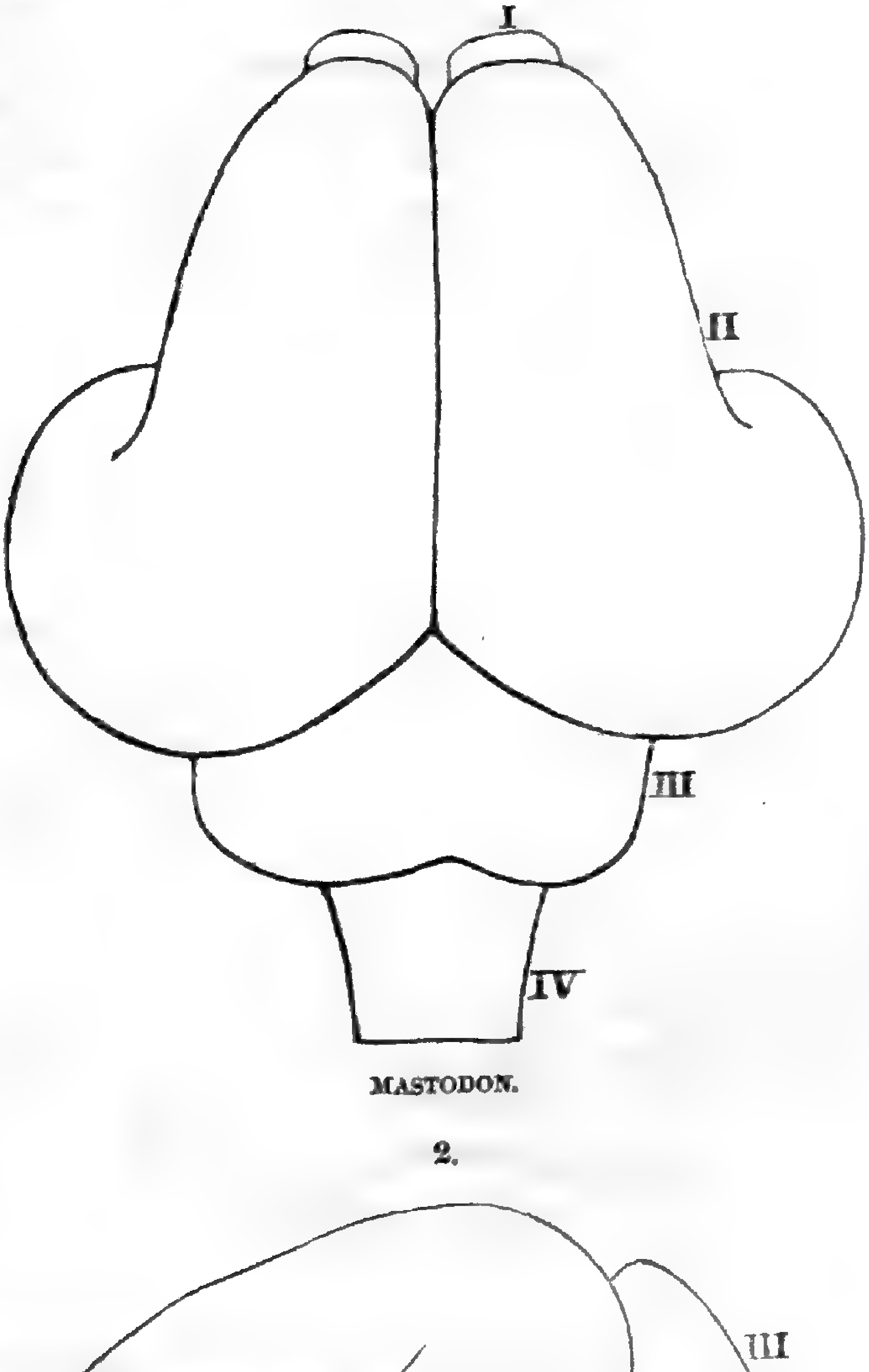
* Page 119.

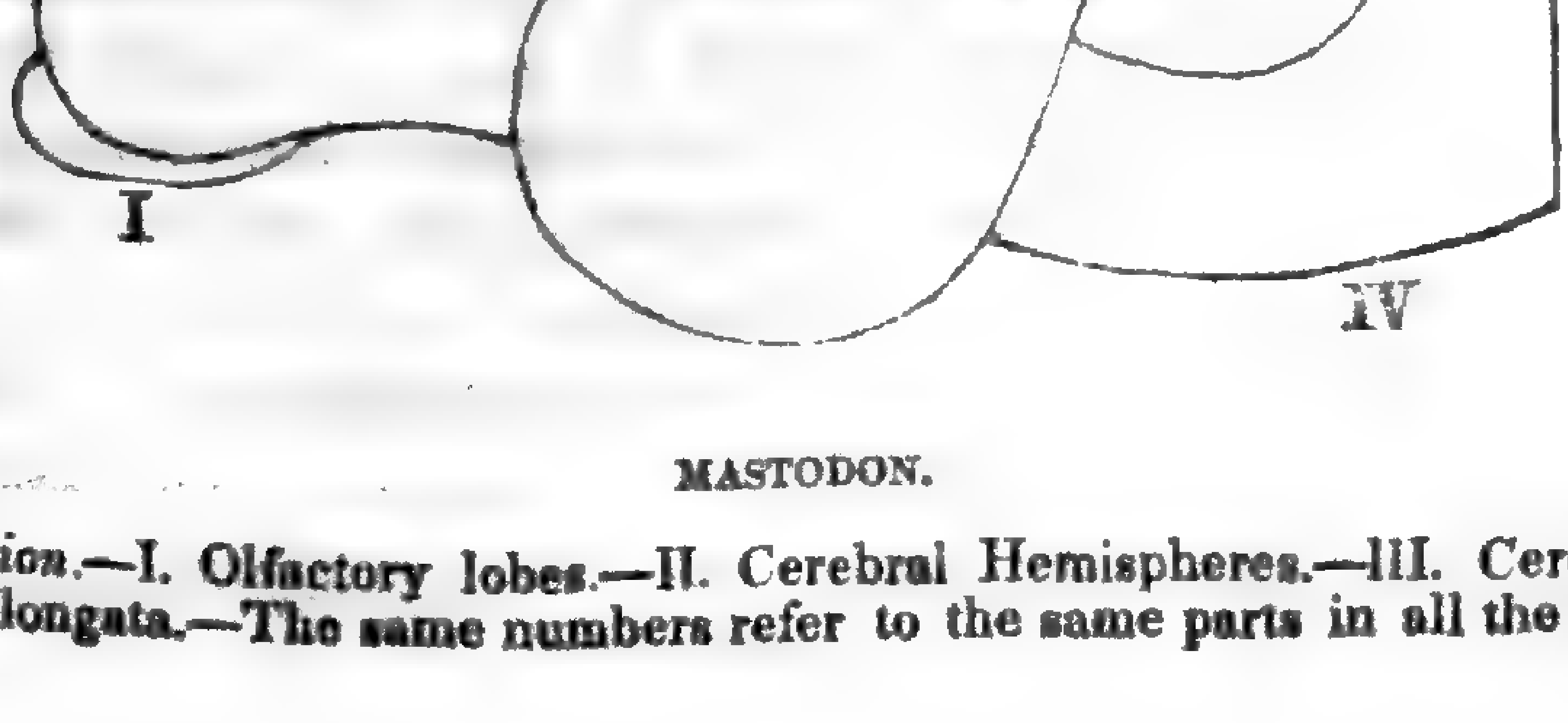
apex directed forwards and in a great measure overlapping the olfactory lobes. This conical portion terminates at the posterior edge of the wing of the sphenoid, which forms the boundary between the orbitar and middle cranial fossæ. Behind this division the brain becomes suddenly increased in breadth from 7⅛ inches, which it is at the division, to 10⅛, which is its diameter through its broadest part.

1.



MASTODON.

2.

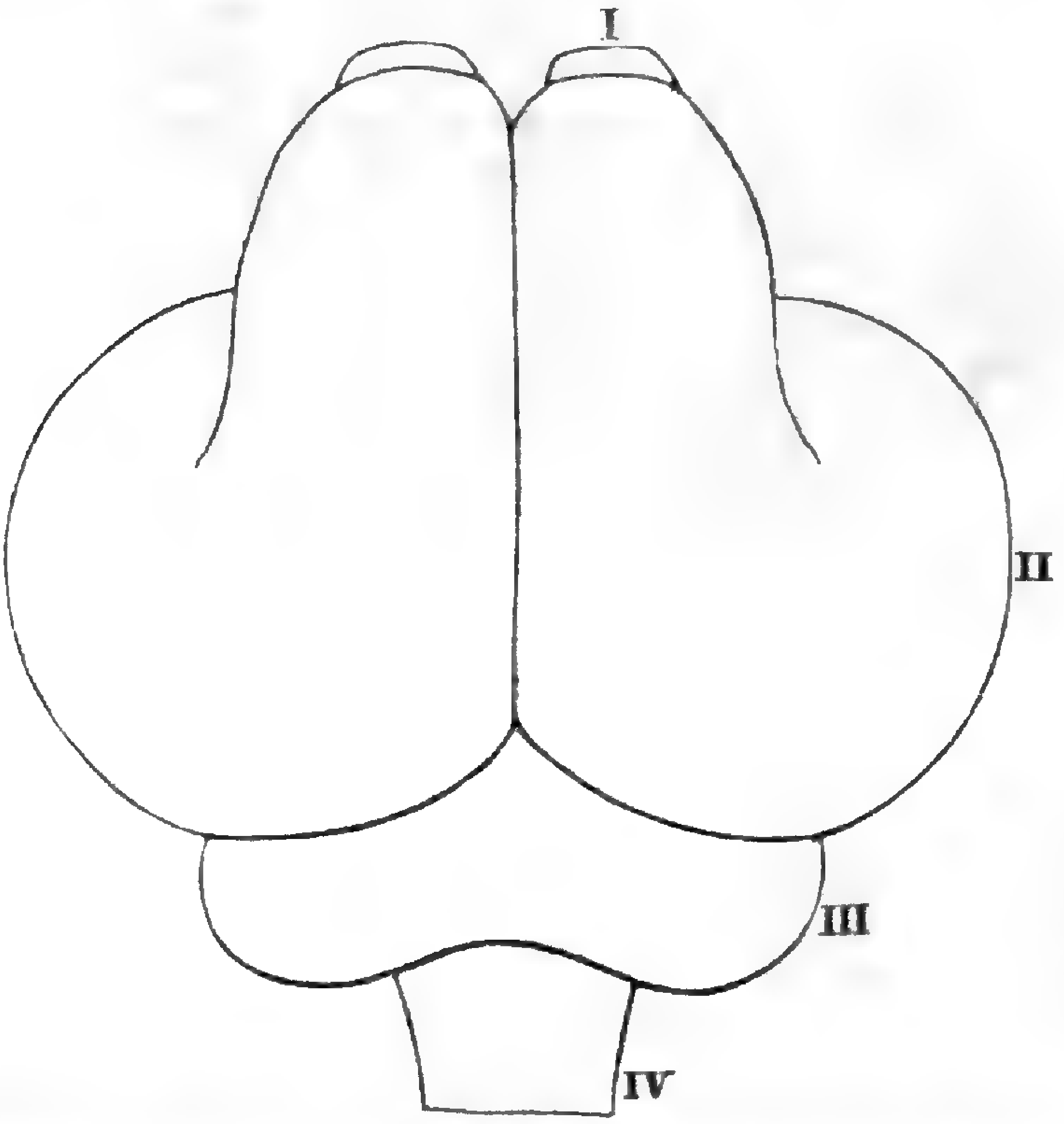


MASTODON.

Explanation.—I. Olfactory lobes.—II. Cerebral Hemispheres.—III. Cerebellum.—IV. Medulla oblongata.—The same numbers refer to the same parts in all the figures.

In Mastodon then as in Elephant the transvere diameter of the brain exceeds the longitudinal, though to a less extent in the former than in the latter; this condition of things exists only in a few instances in the Mammiferous group, and is found principally if not wholly in Cetaceans and Proboscidean Pachyderms.* In Cetaceans the transverse diameter is in still greater excess over the longitudinal, but the cerebral lobes together form a regularly oval mass; in which circumstance it makes a striking contrast with the same parts in Elephants and Mastodons. Fig. 3 represents the outline of the brain of an Elephant, E. indicus, figured and described by Mayer in the memoir previously quoted, and in which the remarkable form of the brain is especially noticed, a peculiarity which Camper seems to have entirely overlooked.

3.



ELEPHANT.

Explanation.—I. Olfactory lobes.—II. Cerebral Hemispheres.—III. Cerebellum.—IV. Medulla oblongata.

The *cerebellar* fossa is well defined, and shows a considerable elevation of the cerebellum, which it appears must have been more uncovered by the cerebral lobes than in Elephants.

The resemblance between the forms of the brain in Mastodons and Elephants, is also of great interest in a zoological point of view. The general conformation of the skeletons of these two

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* See Cuvier Oss. Foss. T. i, p. 481. 3d edition.

genera is so similar, that they have always been approximated in zoological systems, their generic distinctions resting mainly on the difference in the structure and form of the teeth. But after the discovery in Burmah of Mastodon elephantoides, this distinction in some measure lost its value, and more recently the wonderful discoveries of Falconer and Cautley in the Sivalik hills of India, seem to have established an almost imperceptible gradation from E. nomadicus and Africanus, through E. planifrons, E. insignis, and E. canesa, in which last the transverse ridges are destitute of cement, to the different species of Mastodon.*

The determination of the similarity of form in the brains of these two genera, gives us another important character in which they approximate each other, and may suggest the probability that future discoveries may result in the breaking down of all absolute distinction between them; though as yet however the generic boundary is sufficiently well defined in the external forms of the heads and some of the details of the skeleton.

Note.—The figures of the brain of Mastodon given above, were obtained by projection from measurements of the interior of the cranial cavity. As the subdivisions of this cavity are separated by well defined boundaries, and as the bones in mammals are accurately moulded to the surface of the encephalon excepting in the neighborhood of the medulla oblongata, the interior of the cranium may be admitted with scarce a probability of error, as an index of the general figure of the brain. There is nothing to indicate the precise size of the medulla oblongata; the figure of this portion is therefore ideal. Some indications of cerebral and cerebellar convolutions were visible in the interior of the cranial walls, but too ill defined to warrant any attempt at laying them down in the figures. The figures of the Mastodon brain are drawn on the scale of one-fourth of an inch to an inch; the figure of the Elephant's brain is reduced from one by Mayer in the memoir before referred to.

ART. VII.—*On the Auroral Bow of June* 11*th*, 1852; by Rev. CHESTER S. LYMAN.

OBSERVATIONS made upon Auroral Bows by independent observers so situated geographically as to afford reliable data for determining the height of the phenomenon above the earth, are somewhat rare. And as there exist different opinions among philosophers respecting its usual height, it seems desirable than any observations that may throw light on the question should be given to the public in full.

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* **Fauna Antiqua Sivalensis**, being the fossil zoology of the Sivalik Hills in the North of India, by **Hugh Falconer**, M.D., &c., and by T. Cautley, F.R.S., &c.

The position in the heavens of the bow of June 11th, 1852, was noted quite definitely by Mr. E. C. Herrick at New Haven, and by Mr. Sereno Watson at East Windsor, Conn. It was also observed independently by Prof. Olmsted at New Haven, Mr. Hyde at East Windsor, and Prof. Brocklesby at Hartford; and was also seen at Meriden, Springfield, and numerous other places, but not carefully observed.

From the fact that only a single bow was noticed at any place, while the rest of the sky was comparatively free from auroral light, it is safe to presume that the several observers saw the same identical bow. This presumption is strengthened by the fact that it was seen by all the observers at about the same time, and by some of them with certain similar characteristic features, particularly its manner of disappearance. On the supposition of identity also, the observations at New Haven, Hartford, and East Windsor give an unequivocal parallax, and a parallax that gives an altitude corresponding with the determinations of Dalton, Professors Olmsted and Twining, Prof. Challis and many others, who have made similar computations respecting different bows. These observations have usually given an altitude ranging from 100 up to 200 or 300 miles. Mr. Herrick from his own observations at New Haven, and those of Mr. Watson at E. Windsor, computed the height of the bow of June 11th to be not less than 150 miles, as stated in this Journal, vol. xiv, p. 131.

That others may judge of the soundness of this conclusion, as well as of some other inferences which the facts in this case seem to justify, the original observations are here given in full as put in writing by those who made them. Those by Mr. Herrick at New Haven are as follows.

"*Friday, June 11th*, 1852.—Evening: sky clear and pure.

As early as 9 o'clock, there was a strong general Auroral light in the north, through an amplitude of 120°+, with indistinct streaming 20° or 30° high.

Looking out again about 9^h 50^m N. H. m. s. time, I saw stretching from the easterly to the westerly part of the heavens, and passing the meridian a little south of the zenith, a continuous luminous streak or bow, about two degrees in breadth, (as I judged,) and having a bend southwardly near the meridian. There was at this time only a bright general light along the N. horizon, without streamers. The sky was exceedingly clear, and there was no other auroral indication which could be confounded with this bow. There was but one bow visible, and this one was distinct, and moderately bright. The margins were tolerably well defined, and so far as I remember, either margin could in most parts be determined within one-third or one-fourth of a degree. The bow showed no fringe, nor any fibrousness of texture, and when disappearing exhibited none of the usual internal oblique beams, or segments of streamers. It appeared to be simply luminous vapor. I did not at the time note down the exact position of the westerly end, but if I remember correctly it was near *gamma Leonis;* and at an earlier period it probably reached a lower point. The easterly part below the altitude of about 35° was hidden from my view by trees and buildings.

At $9^h\ 52^m$, the bow is central on the star *alpha Coronæ Borealis.*
" " 53 40^s, the southern edge touches *epsilon Bootis,* (*Mirac.*)
" " 54 20 , the bow is fading, and is now central at a point midway between *Arcturus* and *Mirac:* its breadth here is about one-fifth of that distance.
" " 57 0 , the bow has now disappeared, except a segment about 30° long in the northwest. This extends from a point about one-third of the distance from *zeta* to *gamma Leonis* in a gentle curve, convex towards the north, expanding to a breadth of 3 or 4 degrees at the upper part, and terminating at a point midway between *beta Leonis* and *Cor Caroli.* This segment remained visible about a minute without much change of position.
" " 59 0 , no trace of the bow can be seen.

The meridional part of the bow, while I saw it, had a motion southward, but at what rate could not be well determined from so brief an observation. Moreover, the changing character of the sinuosity near the meridional part of the bow embarrassed the observation on the motion towards the south."

Mr. Watson's observations are thus detailed in a letter to Mr. Herrick, dated East Windsor Hill, June 15, 1852.

"My attention was first drawn to the aurora at about 8h. 50m., when a line of streamers, reaching nearly to the zenith, formed with their bright bases of yellowish light an irregular and imperfect arch in the N. and N. W., which contrasted well with the purple shades of evening that lingered below and with the dark sky above. This arch became more regular and perfect, at length extending from 65° E. to 25° W. of N., having a height of 20° or more, but finally sunk into a bank of auroral light, fading from the horizon to an altitude of 30°, the streamers becoming less and less frequent. At 9h. 4m. a bright streamer covers β and γ of the Bear, and at 9m. waves of light are distinctly seen in the north.

The arch commenced at 9h. 23m. with a bright ray to the S. of E. just above the horizon, which in 2m. extended itself entirely across the sky, of nearly uniform breadth except in the E., where it narrowed to a point, not bright nor very sharply defined, but more so upon the N. than the S. edge and brightest overhead. Its direction was this; beginning some 10° S. of E. it passed S. of the Eagle and the Crown, covered the head of Serpens, had Arcturus on its south border and embraced α, δ, η and θ Leonis. Its width was determined by the five stars in the head of Serpens, the north star being on the north border and the arch having $\frac{1}{10}$th of its width below the southernmost. This, if I remember aright, was very nearly the position of the arch of April 7th, 1847. This also like that one was continually but slowly changing its place, not as a whole, but first the portion west and then that east of the zenith, and in such a manner as to form curves at certain points, while the lower portions remained nearly stationary. At 9h. 34m., Arcturus is in its centre, and at 36m. the east portion has also moved south its half. At 42m., Arcturus is upon its north edge and the whole has apparently moved south its width, forming again a regular arch. At 43m. the arch is yet entire but fainter and fades gradually away, from the eastward. At 46½m. a vestige yet remains in the west 1½° or 2° wide, its north edge well defined upon β Leonis. It moves north its width and is wholly gone at 9h. 51m. The arch in the north horizon continued with few or no streamers till after 11 P. M. My watch had probably an error of some minutes."

In a subsequent letter Mr. Watson remarks, "I enclose you another set of observations made entirely independent of mine, by Mr. T. C. P. Hyde, a student of the Seminary." Mr. Hyde's notes are as follows:

"Auroral streamers—visible early in the evening twilight, and continued most of the time till 10½. Direction generally from an arch low in the north toward a point 15° or 20° south of the zenith. Length varying from 6° or 8° to 30° or more. Slight coronal appearances, not far from 8 P. M. Afterwards a column or belt appeared from E.N.E. to W.S.W., through a point south of the zenith. At 9·30 (time not exact) the northern border of the light passed through the south edge of the Northern Crown and its southern was near Arcturus. It was slowly drifting south: left the Northern Crown about 9·40, had Arcturus near its centre at 9·50 and in its northern margin by 10. About 9·50 the southward motion of the western end of the belt was accelerated, so that the belt became concave to the south. At 10·10, the west end was perhaps 3° or 4° farther south than it would have been by a motion uniform with the central and east portion. I did not observe its subsequent return to the northward. At 10·15, a faint line of light could be traced, marking the original position of the belt, separated from the larger belt which had moved south, by a dark interval of perhaps 4° or 6° in width."

Professor Brocklesby, of Trinity College, Hartford, in a letter to Professor Olmsted, which he has kindly permitted the writer to use, describes the bow as having its southern limit, at a quarter to ten, mean time, not more than a degree distant from Arcturus. "I noticed," he remarks, "that the southern margin was quite near to Arcturus, and immediately obtained the time from a watch belonging to Mr. Bushnell, a divinity student. The time was a quarter to ten. For two or three minutes, at least, there was no perceptible motion in the arch southward, near Arcturus. Mr. Bushnell is confident that no portion of the arch reached as far north as the crown, that the *northern* limit was clearly *south* of it." "We are agreed that the distance of Arcturus from the belt (at the time specified above) could not have exceeded one-fourth part of the width of the belt."

Unfortunately for the purposes of comparison, the *times* indicated in the observations given above, with the exception of Mr. Herrick's, are uncertain to a considerable amount. Those for Windsor may be in error ten or fifteen minutes. Professor Brocklesby, from subsequent comparison with a church clock in the city, supposes his time to be not far from correct. In respect to Windsor, this uncertainty is much diminished by the fact, that both at that place, and at New Haven, the bow was observed till it finally vanished. Its disappearance at both places was rapid, and in circumstances somewhat similar. It will perhaps be allowable, therefore, to correct Mr. Watson's time from that at New Haven. If eleven minutes, (which is about what Mr. Watson supposed his watch may have been too slow,) be added to the former, the appearances of the bow at the two places are very readily comparable with each other. It may be remarked also, that the more definite observations at these places were made within a few minutes of the disappearance of the bow. The times noted by Mr. Hyde appear to be given in round numbers, and are consequently of less value than those of Mr. Watson.

From the observations at New Haven and East Windsor, it is easy to lay down on a celestial globe the position of the belt as seen at very nearly the same time from each of these places. This cannot be done however as definitely as is desirable, on account of the rapid southerly motion of the belt, and the varying flexures in some parts of it. The position of a part of the bow near the meridian, as observed by Mr. Herrick, changed as much as four or five degrees in less than a minute. As seen from Windsor the average motion appears to have been much slower, at least in that part of the belt near Arcturus. Nine minutes after that star was in the southern border of the belt, it is mentioned as being in the center of it, and eight minutes afterwards, in the northern border.

On thus laying down the positions of the bow on a globe adjusted to the hour of the day, its parallax, as seen from the two places named, is very obvious. Even if we allow an uncertainty of several minutes in the times, and compare Mr. Herrick's latest, or most southerly position, with Mr. Watson's earliest, or most northerly, there is still left a parallax, though quite small. And if, on the other hand, we compare Mr. Herrick's earliest with Mr. Watson's latest position, the parallax, for the center of the belt, cannot be made to exceed fourteen or fifteen degrees at most.

Making the most probable correction for the times, and obtaining a mean position of the belt on the globe for each place, we estimate the altitude of the bow, in a plane perpendicular to its general direction across the heavens, to be 72° for its southern edge, as seen from New Haven, and 74° for its northern; at the same time, as seen from East Windsor, the lower edge had an altitude of 61° and the upper of 67°.

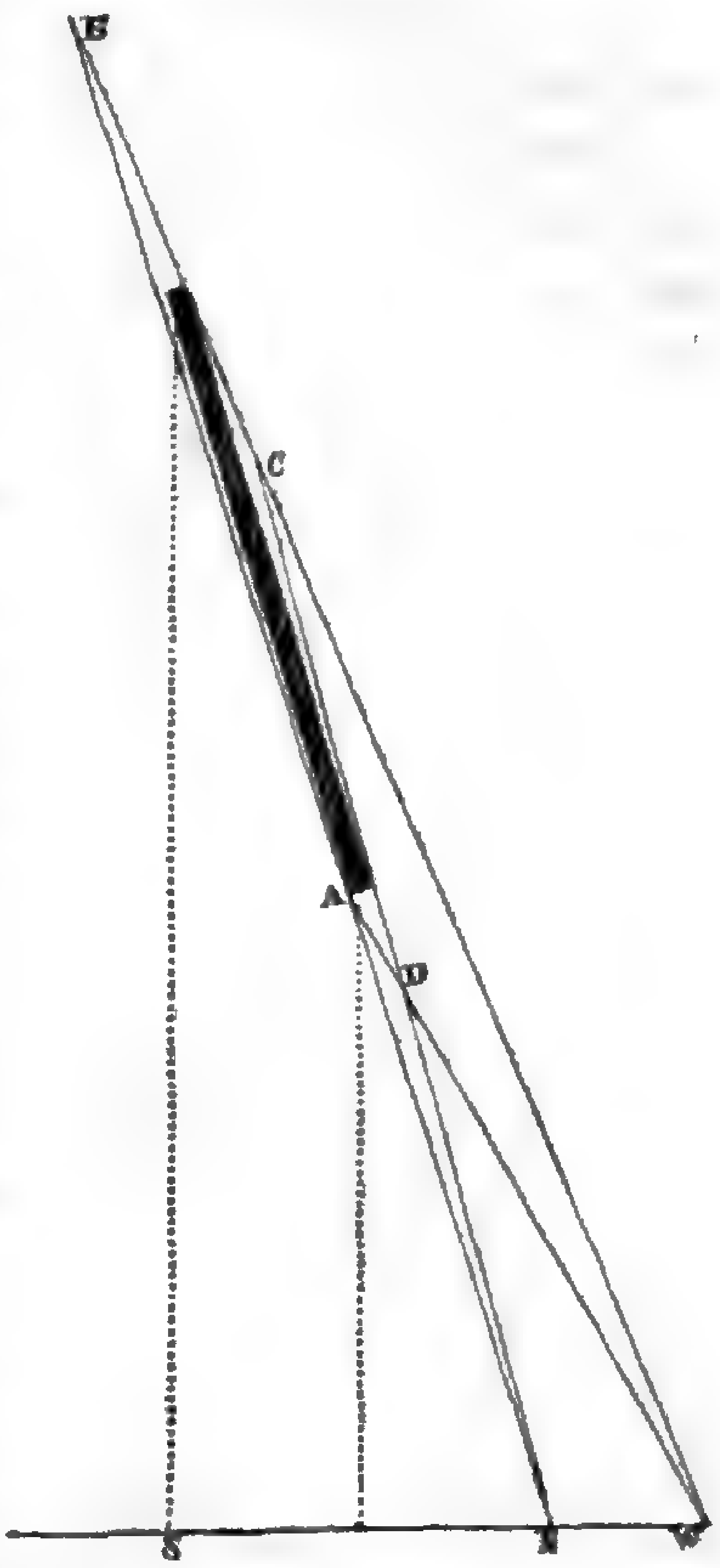
The plane (perpendicular to the direction of the belt) in which these altitudes are taken, lies in a direction S. 8° or 9° W. of the true meridian, which angle is on the opposite side of the meridian from the magnetic variation. The bow, therefore, instead of crossing the magnetic meridian at right angles, made an angle with it about 15° less than a right angle.

In like manner, Professor Twining, (Am. Jour., vol. xxxii, pp. 223, 227,) found the meridian of the Auroral bows of May and August, 1836, to lie on the opposite side of the true meridian instead of on the same side with the magnetic variation.

East Windsor bears from New Haven, according to the best maps, about N. 23° 30′ E., distant forty English miles. The distance reckoned in the direction of the plane in which the altitudes are estimated, is thirty-eight and a half miles.

Before making further use of these data, it may be well to direct attention more particularly to the apparent *width* of the belt. This, at New Haven, is clearly defined by Mr. Herrick to be not far from 2°. He could hardly be much mistaken in estimating one-fifth of the distance between Arcturus and Mirac. This distance is 10° 17′. As seen from East Windsor, the width could not have been less than 6 or 7 degrees. On this point Mr. Watson remarks in a subsequent letter. "For some minutes the belt was nearly stationary over the head of Serpens, and its width for some distance from the meridian very nearly uniform. I then, before any marked motion occurred, noted its breadth pretty accurately by the stars mentioned, the five stars plainly discernible in the head of Serpens, the two westernmost in a line with, and a little east of south of α Coronæ. The northern star was then nearly upon, or a little within, the northern edge of the belt, and the greatest north and south distance of the stars was nine-tenths of the width of the belt. The width was rather greater than less than that I have indicated." The distance between β and ϱ Serpentis, the northernmost and southernmost of the stars referred to, is 5° 42′. This would make the width of the belt not less than 6°. Mr. Hyde's observations confirm this estimate. Prof. Brocklesby's indicate a similar width as seen from Hartford.

If now, with a base of 38½ miles, and the altitudes given above for New Haven and East Windsor, (viz.: 72° and 74° for the lower and upper edges respectively, as seen at the former place, and 61° and 67° for the same at the latter place,) we draw a diagram like the one on the opposite page, it is manifest that a section of the auroral belt must lie *within* the elongated trapezium A, B, C, D. And as each of the four sides of the trapezium is tangent to the belt, its position must be somewhat that of



N, New Haven.
W, East Windsor.
Angle SNA, 72°.
" SNC, 74°.
" SWA, 61°.
" SWB, 67°.
Base NW, 33·5 miles.
Scale, 120 miles to an inch.

the broad line in the figure. Hence, if both observers saw the same belt, and the apparent width was, at each place, that stated above, the belt could not possibly have been either of a cylindrical form, or a flat band lying horizontally. The only possible form to meet the observed conditions, must be that of a curtain or thin sheet of auroral light, seen more or less edgewise by the different observers, and making an angle with the perpendicular as represented in the diagram. This angle, in the case before us, must, as is obvious from the figure, be nearly equal to the zenith distance of the bow as seen from New Haven, or between 16° and 18°. Now this so nearly coincides with the inclination of the dipping needle, (73° with the horizon at New Haven,) that it may fairly be presumed the belt is under the same magnetic conditions as the ordinary streamers, which are known to coincide in direction with the lines of magnetic force, as indicated by a freely suspended needle. On this presumption, the section of the bow, represented by the heavy line in the figure, is drawn with an inclination of 73° to the horizon. Of course, at New Haven it must have been seen edgewise, and the visual lines touching what appeared to be its northern and southern edges, touched, more properly speaking, its northern and southern *faces*, and thus limited not its *width* but its *thickness*. Supposing this to be the true form and position of the belt, and that the contemporaneous altitudes given above are correct, the real vertical width of this sheet or curtain of auroral light must have been not far from 150 miles, the perpendicular distance of its lower edge above the earth being about 140 miles, and that of its upper edge about 280 miles.

The conclusion of Dalton respecting auroral beams, (Meteorology, 1834, p. 165, Prop. 5,) is interesting in this connection, viz.: that, "The distance of the *beams* of the aurora from the earth's surface, is equal to the length of the beams, nearly." He appears to have considered the rainbow-like arches or belts, as a distinct phenomenon from the ordinary beams; though in some manner connected with them. He says, it is very probable they are either at the top or bottom of the beams, and is inclined to think they are at the top. But if the view of the subject taken above is correct, the auroral bow may be regarded as nothing more than a curtain or sheet made up of contiguous beams, and seen more or less edgewise. Such curtains, seen at such an angle as to render their curtain-like character manifest, are occasionally noticed, during an aurora, and some striking examples have been figured by travellers as seen in high northern latitudes, particularly at Bossekop in Finland, 1838–40, by MM. Lottin, Bravais, &c., of the Scandinavian Scientific Expedition. If we imagine such a curtain, crossing the meridian nearly at right angles, and having an inclination equal to that of the dipping needle, to be moving slowly towards the south, at a height above the earth nearly equal to its vertical width, it might present successively, to a particular observer, the following different aspects. When first seen comparatively low in the north, and at a great distance, with other similar sheets of beams before or behind it in the same direction, it would help form the low dense arch of auroral light so often visible a few degrees above the northern horizon. Such a curtain, on moving further south, would, by the effect of perspective, appear to rise in altitude, and become separated from the mass of beams beyond, covering the northern sky with streamers more or less near to each other, or with a diffused auroral light. As it approached the zenith of the observer, the length of the beams would seem to shorten from being seen in perspective, while the light would become more condensed, and the whole assume the form of a broad arch, or diffuse belt, more or less irregular and feathery, spanning the heavens. On passing to the south of the zenith, its apparent width would diminish, and the intensity of its light increase, until it reached the direction of the dipping needle, when being seen edgewise, its apparent breadth would be reduced to a minimum, and its margin become better defined. If it passed still further south, it would again increase in width, and diminish in brightness, until it finally vanished, or resolved itself into ordinary streamers. This change in the apparent width of the belt as it passed southwardly from the zenith, has been often noticed. It is mentioned particularly by the observer at Edinburgh, of the aurora of March, 1826, discussed by Dalton in the Phil. Trans. for 1828.

Whether this be the true theory of the form and position of the belt or not, the fact that the observations before us seem to require such a theory, should direct the attention of observers more particularly to the precise *width* of the belt, as well as to its *altitude* or position among the stars.

The numbers given above for the height of the bow of June 11th above the earth can be regarded only as an approximation, owing to the difficulty before mentioned of deciding upon the precise parallax. Taking the largest parallax possible in the case without regard to coincidence of time, no part of the arch could have been less than 100 miles above the earth. While if we use the smallest parallax that might be thus made out, we should place the phenomenon at a height of three or four hundred miles. But such a use of the data is unwarranted. The most probable result is that which we have given. It may be remarked further, that at the height of 200 miles, the angle of 2° subtended by the belt at New Haven, would give for its actual *thickness* about seven miles.

If the segment of the arch remaining in the west after the rest of it had vanished, be laid down on the celestial globe as seen both from New Haven and East Windsor, the difference in the apparent positions will show a similar parallax to that determined from observations near the meridian. The altitude of the lowest point in the west as seen by Mr. Herrick was about 24°. If the real height of this point was 140 miles, its distance from the observer was less than 300 miles, which in the direction N. 80° W. would make it perpendicular over western New York.

Art. VIII.—*Notes on Kilauea and the recent Eruption of Mauna Loa;* by Rev. Titus Coan.[*]

I have but recently returned from a tour of nearly two hundred miles—embracing the shores of Puna, a visit to old Kilauea, and an ascent to the seat of the late eruption on Mauna Loa. On this expedition I was accompanied by two sons of Mr. Alexander, one of Mrs. Chamberlain's, three of Mr. Lyman's, and one of my own. Our route through Puna you will remember with all its "lions." You recollect the limpid lake, full of mullet, at Keau; the green lake in a crater at Kapolo; the hot pool in the cavern at Opihikao; the tepid lake at Kalepena; the fissure bath at Kahaualea; the salt-works at Kealakomo, &c. From the last named place, which is the farthest point you visited, we ascended a precipice of 1000 feet and in one day reached Kilauea. Here we spent one night, and were cheered and entertained by the brilliant fireworks of old mother Pele. I had visited this scene in March, and found the action in the crater much increased. On this occasion the action was still more intense. The great dome, one mile and a-half in circuit, and several hundred feet high, has now lost its key stone, and the massive arch is fallen in. The orifice on the summit is some two hundred feet in diameter, and down this opening you look directly upon the raging lake below. On one side the dome is rent from the base to the summit, and through this fissure, smoke and lavas

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[*] From a Letter addressed to C. S. Lyman, dated Hilo, Hawaii, July 31, 1852.

pass off from the boiling chaldron. This fiery lake, so long concealed by the ponderous dome, is gradually rising and lifting and rending the superincumbent strata of which the great dome is composed, and threatening at no distant day to engulf the whole overhanging mass within its burning bowels.* Crag after crag, and mass after mass, are being loosened from the walls of this fiery orifice and precipitated like an avalanche into the abyss below. Thus the conflict will go on, until the old furnace of Vulcan opens to view in all its original dimensions, and burns, and glows, and rages, with the vehemence of former years. Aside from this increased action within the dome, no important changes have occurred in the crater for two years past. From Kilauea, we took a northwest course toward the seat of the late eruption. For three miles we had a good path and passed through immense fields of Ohelo, a variety of whortleberry. We then entered a thick forest, about four miles deep. From this we issued into an open field of lava, sprinkled with shrubbery, and inhabited by wild goats, wild geese and wild birds. On, on we went, climbing and still climbing, until the crater and the petrified river, for which we were toiling, came into view, and at night we encamped within five miles of the cone whose awful thunderings and glaring fires spread such consternation in February and March.

Taking an early start the next morning, at eight, A. M., we stood on the summit of this cone and surveyed it with perfect composure. It is now extinct, with the exception of some heat and steam from some of the crevices. We went round it, over it and into it. It is seventy-four chains in circumference at its base, nearly five hundred feet high, and has a crater four hundred or five hundred feet deep. It is an irregular, hollow, truncate cone. I found its summit to be a little higher above the sea than Haleakala on Maui, which is 10,000 feet, and which was in full view. Mauna Kea was also standing uncovered in bold relief, towering in sublime grandeur to the heavens.

From this summit, we could also survey the cooled stream down the mountain side, over the blackened scoria plains, far into the forests of Hilo. Byron's Bay, also, and the shores of Hilo, lay like a map at our feet.

At several points at the base of the mountain, and in the forests, the lava was still smoking, but for the most part it was extinct; and the atmosphere was so pure and so free from smoke that we enjoyed a most grand panoramic scene. Where the molten stream issued from the crater it made an opening in the rim, through which it flowed with great rapidity. From the crater several

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* The reader will remember that this lake is in the crater of Kilauea, at its southernmost extremity, and covers but a small part of its whole bottom, although the dome which has covered it is 1800 to 2400 feet in diameter at base. The lake when fully open, measures 1000 feet by 1500 in diameter.

miles down the mountain the stream is half a mile wide, but at the base of the mountain it spreads to the breadth of three or four miles. In some places it formed a multitude of channels, and enclosed numerous islands of ancient lava and scathed and charred forest trees. The whole length of the stream, including its windings, may be forty or fifty miles, and it approached within about ten miles of Hilo.

I engaged men to cut through the forest from Hilo, find the terminus of the stream, trace it through the woods, meet me on the mountain, and lead me down the channel to Hilo. But the men did not commence in season, so that we had left the mountain by another route before they came up. This was a disappointment, as I had intended to measure and know definitely how near the eruption approached us, and whether its direction would, probably, have brought it to our station. These facts I have yet to determine.

Had the flow been direct, and had it been confined to a channel of half a mile in breadth, it would have reached the shore in less than two days. But its consistency was so great, its windings so numerous, and the obstacles in its track so many, that, although the great fountain played furiously for twenty days, still the stream spent itself in the inland regions. And there it now lies like a petrified serpent, stiffened in death in the forests behind us.

But to return to our point of view on the cone. What a contrast! This whole frowning pile on which we stood was but recently a glaring pyramid of fire, and from this dark throat, down which we now calmly gazed, ascended a fiery column a thousand feet in diameter and seven hundred feet high, with mutterings and roarings that might make the stoutest heart "fear and quake." This atmosphere, now so pure and cloudless, was filled with whirling, careering clouds of sulphurous smoke—murky, red, blue, green, black—darkening the heavens, hanging like awful portents of wrath above, or sweeping away in convolving and angry masses to the distant horizon. Here I now calmly viewed the spot, on which in February last, I sat surveying this terrific pile of fire, and feeling its hot flashes on my very cheek; and the place where I then kept vigils through the live-long night, and saw, and heard, and felt things unutterable. Now, all was calm as death—all still as the grave—all wild and desolate as chaos.

I found sulphur and gypsum in small quantities, but I noticed no other salts. There is nothing new or striking in the products of this eruption. The common lavas of Hawaii abound here. A kind of pumice is very abundant, and widely scattered. We found it ten miles from the crater and it grew more and more abundant till we reached the cone where it covers the whole region to the depth of five or ten feet.

ART. IX.—*Temperature of the air and surface water of the Sea, taken on a voyage from Samoa to Valparaiso, in* 1841; by W. C. CUNNINGHAM.*

1. FROM THE HARBOR OF APIA, ISLAND OF UPOLU, TO TAHITI.

Date	Latitude.	Longitude.	Winds.	Sea.†	Air.†	Weather.
May 11	15° 2′ S.	172° W.	N.E.	78·30	77	fine.
12	15 ·02	172 ·37′	S.S.E.	78½	78	showery.
13	16 ·04	"	E. by S.	78·10	78	do., heavy rains.
14	17 ·27	174 ·43	S.E.	78·	78	dark.
15	17 58	174 ·16	E.	78·	77	fine but cloudy.
16	18 ·50	173 ·41	S.E.	78·	76	do. do.
17	19 ·47	173 ·28	S.E.	78·	76	clear.
18	19 ·37	172 ·41	S.	77·¾	71	clear and fine.
19	19 ·57	170 ·47	S.	76·	75	cloudy.
20	20 ·21	169 ·11	S by E.	76·½	74	cloudy.
21	20 ·16	167 ·21	S. by E.	76·½	72	cloudy.
22	20 ·18	167 ·03	Var.	76·	74	clear.
23	21 ·09	166 ·37	S.	74·¾	76	dark.
24	21 ·46	164 ·29	S.	75·	75	cloudy.
25	26 ·30	163 ·33	S.	76·	74½	fine.
26	19 ·52	163 ·01	S.	77·	75	dark.
27	19 ·23	161 ·53	S.E.	73·	75	do.
28	20 07	162 ·22	S.E.	73·	76	fine.
29	21 ·04	162 ·54	S.S.E.	72·	76	cloudy.
30	21 ·16	162 ·46	E.S.E.	71·	76	cloudy.
31	23 ·00	162 ·45	N.N.E.	72·	76	clear.
June 1	22 ·06	160 ·48	Var.	74·	76	fine.
2	22 ·46	161 ·19	S.S.W.	74·	74	clear.
3	21 ·00	160 ·00	E.	74·	75	fine; at *Rarotonga*
11	22 ·21	160 ·20	E.	73·	72	fine.
12	22 ·24	160 ·25	E.	73·	72	do.
13	22 ·49	159 ·33	Var.	73·	72	do.
14	22 ·29	158 ·54	E. by S.	72·	72	do.
15	22 ·25	159 ·37	N.N.E.	71·	71½	do.
16	22 ·37	159 ·05	Var.	71·	71	at *Mangaia.*
17	..	..	Var.	70·	71	fine.
18	..	..	S.S.E.	68·	72	do.
19	21 ·39	156 ·42	S.E.	68·	72	dark.
20	21 ·06	155 ·47	S.S.E.	68·	73	do.
21	20 ·53	154 20	S.S.E.	68·	74	fine.
22	20 ·36	152 ·34	S.S.E.	68·	76	do.
23	20 ·21	151 ·18	S.E.	70·	76	do.
24	19 ·10	151 ·11	S.E.	71·	76	do.
25	..	..	E.	..	..	*Tahiti.*

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* The above table of meteorological observations were received by the writer long since, with a letter dated Talcuhuano, Chili. Mr. Cunningham, in 1840, was English Vice Consul at the Samoan or Navigator Islands in the Pacific, where the writer had the pleasure of making his acquaintance. The table has peculiar interest, since the route travelled is one seldom passed over by vessels.—J. D. D.

† Mean temperature.

2. FROM TAHITI TO VALPARAISO.

Date.	Latitude.	Longitude.	Winds.	Sea.*	Air.*	Remarks.
Aug. 26	18°·77′	151°·01′	S.E	73	76	fine.
27	20 ·10	151 ·33	S.E.	72	75	clear.
28	22 ·02	152 ·06	S.E.	72	75	do.
29	22 ·18	152 ·45	S.E.	75	73	do.
30	22 ·30	151 ·38	Var.	76	72	do.
31	23 ·15	152 ·47	S.E.	68	72	do.
Sept. 1	24 ·24	152 ·51	S.S.E	68	72	do.
2	25 ·14	152 ·12	N.N.E.	69	72	cloudy.
3	26 ·13	151 ·41	S.W.	69	70	clear.
4	27 ·18	150 ·47	S.W.	65	66	fine.
5	28 ·46	149 ·49	S.W.	63	68	clear.
6	28 ·40	149 ·49	S.W.	62	66	do.
7	29 ·21	150 ·21	W.	61	65	rains.
8	30 ·19	151 ·40	S.E.	60	65	cloudy.
9	31 ·30	152 ·43	S.E.	58	60	squally; dark.
10	32 ·30	152 ·46	S.E.	58	60	do. do.
11	33 ·45	151 ·56	Var.	58	57½	cloudy.
12	34 ·42	150 ·27	Var.	56	58	thick and cloudy.
13	35 ·43	148 ·53	N.E.	56	56	cloudy.
14	36 ·50	147 ·15	N.E.	56	56	clear.
15	38 ·19	146 ·37	Var.	55½	55	cloudy.
16	39 ·23	145 ·38	N.E.E.	53	52	do.
17	40 ·18	143 ·43	N.E.	50	51	rain; dark.
18	40 ·01	141 19	N.E.	52	52	do. squally.
19	39 ·05	139 ·11	N.N.E.	55	54	clear.
20	38 ·24	136 ·58	N. by W.	56	55	foggy.
21	38 ·09	134 ·08	N.N.W.	56	54	do.
22	37 ·42	130 ·38	N.N.E.	56	55	cloudy.
23	37 ·23	127 ·22	N.N.W.	55	54	rains.
24	36 ·52	124 ·06	N.N.W.	56	54	do.
25	37 ·05	121 ·00	N.W.	58	57	clear.
26	37 ·05	117 ·32	W.	56	55	do.
27	37 ·11	114 ·18	N.W.	56	54	squally.
28	37 ·03	112 ·19	Var.	58	57	do.
29	36 ·47	108 ·58	N.W.	57	55	cloudy.
30	36 ·48	106 ·31	W.	57	55	do. mild.
Oct. 1	36 ·29	104 ·12	Var.	58	57	squally.
2	36 ·22	103 ·30	Var.	55	56	do.
3	36 ·42	101 ·00	N.N.W.	58	56	cloudy.
4	37 ·12	97 ·06	N.W.	58	57	do.
5	36 ·58	94 ·30	W.N.W.	58	56	do.
6	37 ·11	90 ·20	W.N W.	56	54	clear.
7	36 ·18	88 ·11	W.N.W.	57	55	do.
8	35 ·28	84 ·55	N.W.	56	56	do.
9	34 ·14	82 ·08	N W.	54	56	do.
10	34 ·06	74 ·25	Var.	57	57	do.
11	34 ·03	73 ·06	S.W.	57	56	fine.
12	34 ·48	72 ·10	N.N.E.	57	57	do.
13	33 ·39	72 ·40	N.	56	57	do.
14	33 ·33	72 ·50	N.W.	56	57	do.
15	33 ·10	72 ·04	S.	56	56	do.
16				55	54	do. at *Valparaiso.*

* Mean temperature.

Art. X.—*Notice of a Binocular Microscope;* by J. L. Riddell.

I devised last year, and have lately constructed and used, a combination of glass prisms, to render both eyes simultaneously serviceable in microscopic observation.

Behind the objective, and as near thereto as practicable, the light is equally divided, and bent at right angles, and made to travel in opposite directions, by means of two rectangular prisms, which are in contact by their edges somewhat ground away. The reflected rays are received at a proper distance for binocular vision, upon two other rectangular prisms, and again bent at right angles; being thus either completely inverted, for an inverted microscope; or restored to their first direction, for the direct microscope. These outer prisms may be cemented to the inner, by Canada balsam; or left free, to admit of adjustment to suit different observers. Prisms of other form, with due arrangement, may be substituted.

I find the method is applicable with equal advantage, to every grade of good lens, from Spencer's best sixteenth, to a common three inch magnifier; with or without oculars or erecting eye-pieces; and with a great enhancement of penetrating and defining power. It gives the observer perfectly correct views, in length, breadth and *depth*, whatever power he may employ. Objects are seen holding their true relative positions, and wearing their real shapes. A curious exception must be made. In viewing opake solid bodies, with one eye-piece to each eye, depression appears as elevation, and elevation as depression, forming a singular illusion. For instance, a metal spherule appears as a glass ball silvered on the under side; and a crystal of galena, like an empty box. By the additional use of erecting eye-pieces, the images all become normal and natural. Match drawings of any solid object, made from each eye-piece, by the aid of the camera lucida, when properly placed in the common stereoscope, appear to stand out in natural relief. These, if engraved and printed in the proper position with respect to each other, might find an appropriate place in books on the arts and sciences.

In constructing binocular eye-glasses, I use, for lightness and economy, four pieces of common looking-glass, instead of prisms.

With these instruments, the microscopic dissecting knife can be exactly guided. The watch-maker and artist can work under the binocular eye-glass, with certainty and satisfaction. In looking at microscopic animal tissues, the single eye may perhaps behold a confused amorphous or nebulous mass, which the pair of eyes instantly shapes into delicate superimposed membranes, with intervening spaces, the thickness of which can be correctly estimated. Blood corpuscles, usually seen as flat disks, loom out as oblate spheroids. In brief, the whole microscopic world, as thus displayed, acquires a tenfold greater interest, in every phase exhibiting, in a new light, beauty and symmetry indescribable.

University of La., New Orleans, Oct. 1, 1852.

ART. XI.—*On a new Method of Illuminating Opake Objects, for the high powers of the Microscope:—and on a new Achromatic Condenser;* by J. L. RIDDELL.

THE front or terminal combination of the objective, is made to condense light upon the opake object, by sending rays of light from behind, through the marginal border of the lens.

To accomplish this, a circular disk of fine plate glass, say near a fourth or fifth part as thick as the diameter of the lens, is bevelled on its outer margin, by grinding and polishing to an angle of 45°. A hole is drilled through the center of the disk, of a diameter, say two-thirds, three-fourths or four-fifths (dependent upon the angle of aperture,) as great as that of the lens. The margin of this hole is also bevelled at an angle of 45°, down to a clean sharp edge. Both rings of bevels are on the same side of the glass, so that if considered as projected, the lines would cross each other at right angles.

I find no insurmountable difficulty, in giving an exquisite form and finish to these disks. I mount and revolve the disk on a good rose lathe; at the same time the grinding or polishing tool is revolved by an overhead motion, the spindle carrying the tool being mounted upon a slide rest, and admitting of a protrusive movement at an angle of 45° to the axis of the lathe.

The disk being finished, is to be placed centrally behind the lens, the bevelled margins looking backward, and the sharp inner edge almost or quite touching the lens. Parallel rays of light being thrown upon the disk, in the direction of the axis of the objective, from below in the direct, from above in the inverted microscope, a ring of parallel rays is sent, by two successive internal reflections from the bevelled surfaces, so that, with direction reversed, the light traverses the outer margin of the objective, and by it is condensed upon the object in focus.

I tested this method of illumination in March last, sufficiently to be satisfied of its great value; more especially where the objective is of very short focal distance, and where consequently, other means of illuminating opake objects, cannot, on account of the nearness of the objective to the object, be resorted to.

New kind of Achromatic Condenser suggested.

A larger, thicker, similarly bevelled disk, with the bevels on opposite sides of the plate glass, and their lines of inclination coincident, would probably serve as an efficient achromatic condenser of parallel rays. By attaching centrally, on the side opposite the bevel, achromatic lenses of proper size, or a good doublet combination, a most valuable form of achromatic condenser, would I think be produced, useful for general microscopic illumination. I have not yet put the plan in practice.

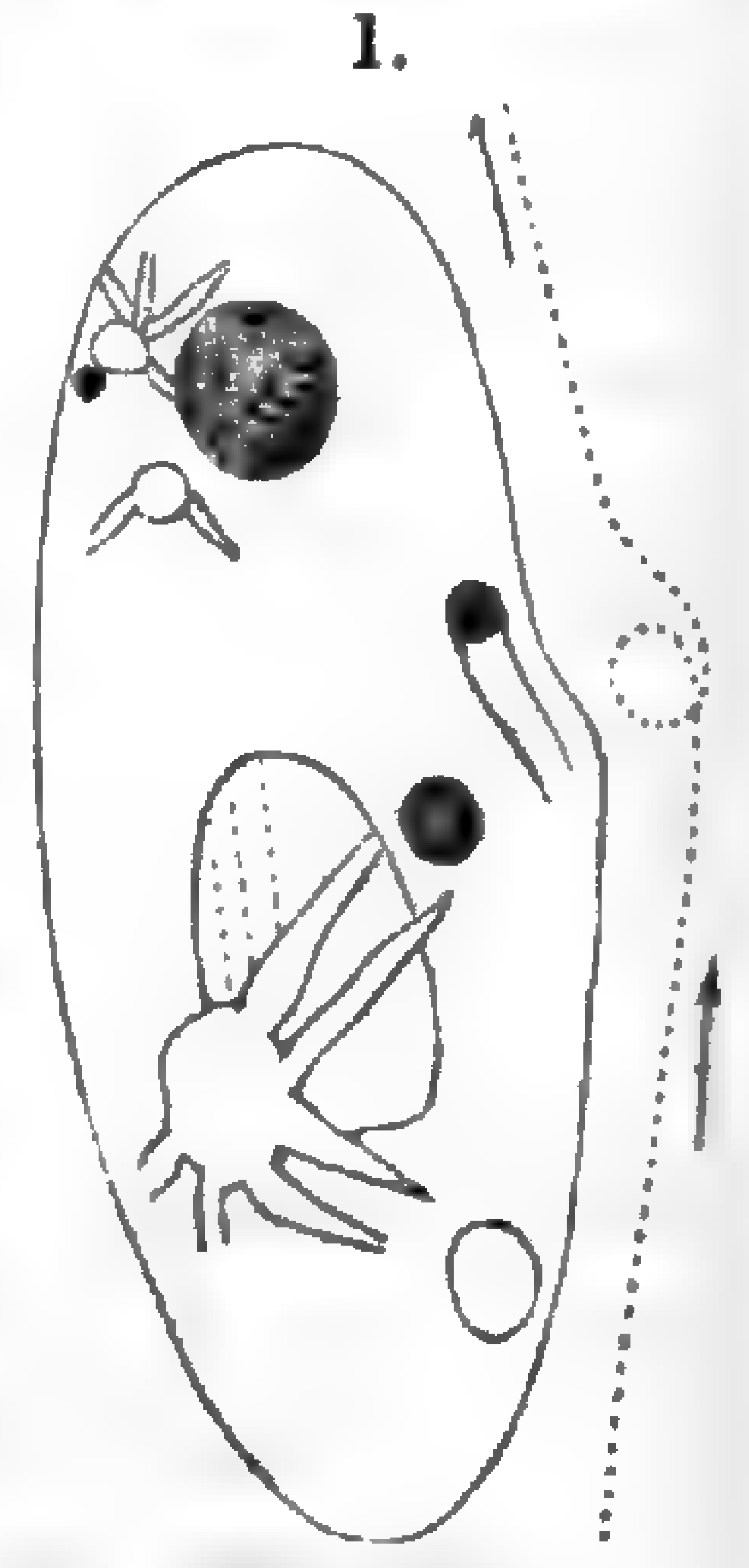
University of La., New Orleans, Oct. 4, 1852.

Art. XII.—*On the Paramecium aurelia;* by Ogden Rood, A.B.

[Read before the Berzelian Society of Yale College, Nov. 30.]

Having accidentally produced a large crop of the Paramecium aurelia in an infusion of hay, I was tempted from their very abundance to make some observations. One of the most remarkable features of this animalcule is the possession of two or more star-like contractile vesicles. Ehrenberg, according to Pritchard, "considers the rays of the star-like vesicle as a ductus spermatici, which is long and enters the ovarium at many points."

1.



200 Diam.

It will be seen by an attentive examination that the said duct discharges *into*, and not from, the vesicle a quantity of liquid which distends and fills it in about a minute, when the vesicle contracts ejecting the liquid from the body by a small opening: then the ducts empty into the vesicle their immediate contents and afterwards recommence the filling operations as before. Now it is evident that the liquid thus thrown off by the creature cannot be an animal secretion, for the amount is too enormously large: moreover it differs not in its refracting power from water; the most natural conclusion then is that it is water. On placing a number of these animalcules in water mixed with indigo and compressing the drop so that they shall be held *nearly* stationary, but by no means crushed, the action is apparent; the indigo with the water is seen to enter by the mouth near the middle of the body, and at the bottom of the mouth the pigment is rolled around till it forms a ball: meanwhile the ducts are seen to distend conveying the water from the mouth into the respective cavities. If this view of the matter be correct, the P. aurelia is not, as was formerly supposed, possessed of male organs. I have not been able, except in two or three doubtful cases, to trace the ducts *completely* to the mouth. The vesicles with the ducts are situated near the surface and immediately under the investing membrane, being thus out of the way of foreign bodies introduced into the interior of the animalcule. It is to be remarked that the cavity into which the ducts empty is not one fortuitously formed in the mobile substance of the body, but is lined with a distinct membrane. This can be observed by cautiously crushing an individual so as merely to rupture the integument, when the contents pour out: the vesicle with the water contained in it will then pass out without breaking up and mixing with the surrounding particles. The action of the cilia surrounding the body would seem to be involuntary, for when the body is much broken and the contents pouring out, they continue their motion with unabated vigor, differing in this respect from those of the mouth.

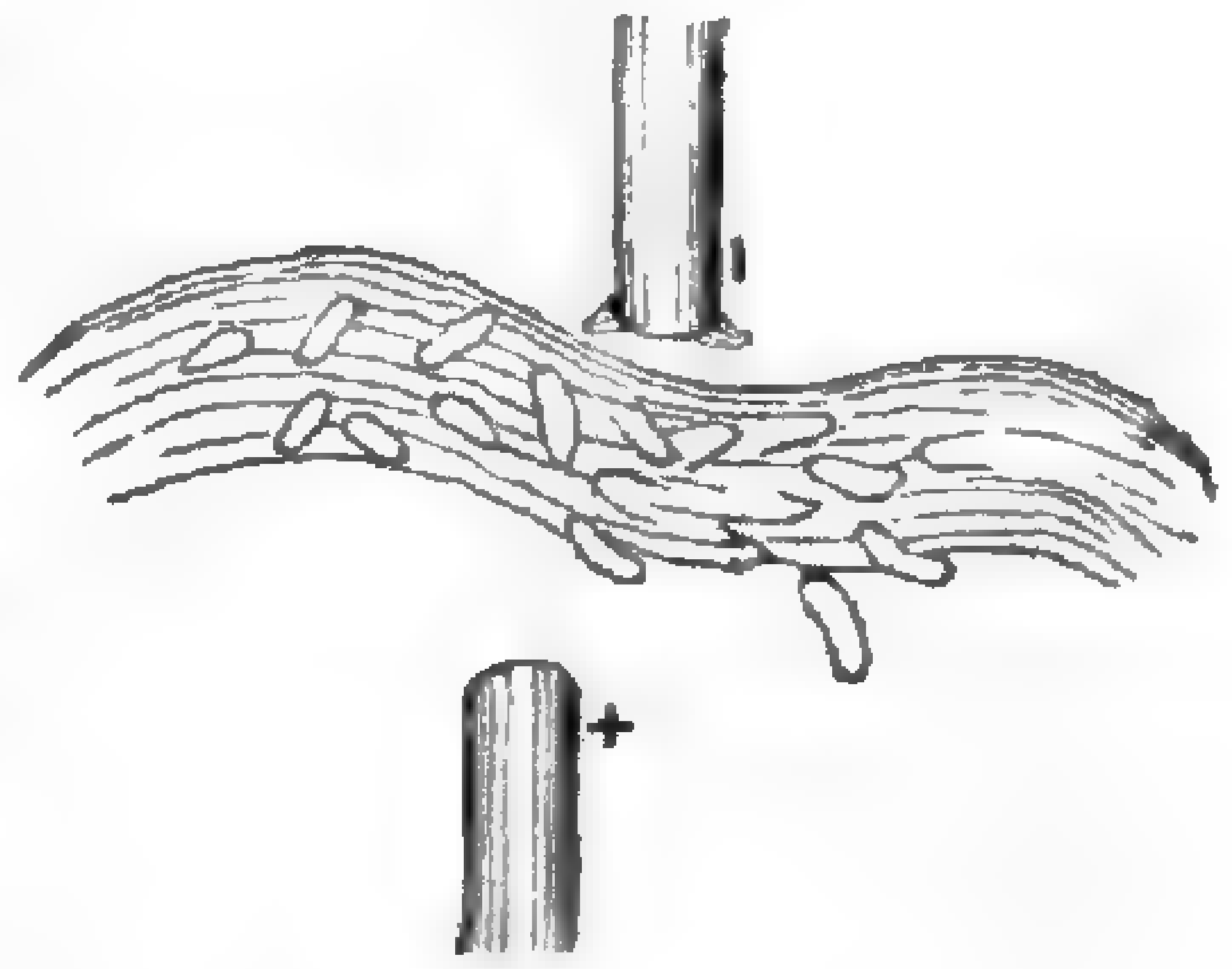
When a number of these animalcules are dried on a plate of thin glass and afterwards heated to redness, an inorganic residue remains corresponding to each individual. This residue although not differing materially in shape from the original, yet has been so much shrunk that it is not more than one-fourth of its size. On treating it with hydrochloric acid it is not attacked, whence it is supposed to consist of silica. It would seem that the deposit takes place in the investing integument, as this though flexible is possessed of considerable toughness.

2.

200 Diam.

On passing a feeble galvanic current through water containing these animalcules, on the circuit being completed, a streak of organic matter begins to form between the poles, but nearer the negative; animalcules in the neighborhood and those touching it cease to swim forward, revolve for some time on their longer axis and then move no more. Examined with a high power, neither mouth nor body cilia are seen to be in action; the body may be observed to be gradually dissipating, and the fine contents arranging themselves along the band. Many burst outright, particularly those which approach near the poles, discharging their entire contents; these also become arranged along the band. A few wheel animalcules which happened to be in the water were by no means equally affected. I neglected to measure the bubble of hydrogen produced, but in no case could it have been larger than $\frac{1}{100}$th of an inch, even after the lapse of several minutes.

3.



15 Diam.

On the application of different reagents these effects followed: alcohol soon caused the action of the mouth to cease which was shortly followed by the cessation of the action of the body cilia —death of course ensuing; often the soft contents contracted leaving a portion of the integument unoccupied. Phosphate of soda caused death in a few minutes; sulphate of magnesia, chlorid of ammonium, acetate of lead, and perchlorid of mercury caused death immediately. Cyanid of potassium the same, attended by instant rupture of membrane and violent discharge of contents. When a quantity of oxalate of ammonia is added to the water in which they are swimming, its immediate effect is to stupefy; the action of the mouth and of the cilia cease and to all appearance the animalcules are dead. But in the course of a few minutes they revive and swim about with undiminished vigor; death does not follow, at least not under several hours.

Neither ferricyanid of potassium nor neutral chromate of potash cause death, at least not under several hours. This last fact suggests the possibility of chemically injecting, even while living, these and other species of infusoria, by the mixture of proper reagents causing colored precipitates. The precipitation would probably take place not only in the surrounding fluid but also in the body of the animalcule, thus demonstrating its structure.

Art. XIII.—*On the Causes which may have produced Changes in the Earth's Superficial Temperature;* by W. Hopkins, Esq., M.A., F.R.S., Pres. G.S., and Pres. Cambridge Phil. Soc.*

Having discussed the operation of internal and external causes on the temperature of the surface of the earth, I now proceed to the consideration of the influences of superficial causes depending on the configuration of land and sea, and on the oceanic currents which result from such configuration, or are greatly modified by it. The admirable map of isothermal lines by Humboldt and Dove, embodying, as it does, all the best-established observations on temperature in all the accessible regions of the earth, affords us data for this investigation far superior to all we have hitherto possessed. Every geologist is aware how long and ably Sir Charles Lyell has advocated the efficiency of the above-mentioned causes of change of climatal conditions; but before the publication of this isothermal map, the geologist had no adequate means of estimating numerically the effects which these causes were capable of producing. The want of this quantitative evaluation of the intensity of assigned causes has hitherto necessarily given to the theoretical views founded upon them much of a conjectural character, which it is my object with the improved means we possess, as far as possible to remove.

Every separate configuration of land and sea which we may suppose to have existed at any assigned geological period would require a separate investigation, in order to ascertain its effect on the climatal conditions of that period. In this paper I shall restrict myself to the examination of those hypothetical cases which, according to the general views of different geologists, may have been actual cases during the later periods of geological history; and my more especial object will be, moreover, to ascertain whether any of these supposed configurations will enable us to account for the cold of the glacial period in our own region of western Europe; and, if so, which of them must be regarded as most effective for this purpose.

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* From the Quarterly Jour. Geol. Soc., viii, p. 56.—In citing this memoir, we omit Part I, which treats of the Influence of the Earth's Internal Heat and of the Heat radiating from external bodies on the Earth's superficial temperature. The course of argument is mentioned in this Journal, [2], vol. xiv, p. 282.—Eds.

9. In examining the course of the isothermal lines for the northern hemisphere, we are at once struck by their extraordinary deviations from parallelism with the equator, which must be considered as their normal type. The most remarkable of these deviations is that which exists in the northern part of the Atlantic and in the adjoining parts of the North Sea. The isothermals for every month, but especially those for the winter months, have an extraordinary deviation and convexity towards the north. Again, in northeastern Asia the abnormal courses of these lines are almost equally remarkable. For the winter months, the deviation, and consequent convexity, of the lines is here to the south; while the summer lines deviate, on the contrary to the north. Deviations also exactly similar to those of northeastern Asia exist in the northern part of the New Continent. The deviations from the normal types in the southern hemisphere are much smaller, the principal ones being those on the western coast of South Africa, and the western coast of South America respectively.

The abnormal forms of the isothermals in the northern Atlantic and North Sea are manifestly due principally to the warm waters of the Gulf Stream; those of eastern Asia and North America are attributable to the existence of large masses of land in high northern latitudes; while those above-mentioned in the southern hemisphere are immediately traceable to the influence of the well-known ocean-currents setting from the south towards the equator along the coasts of southern Africa and South America. The water of these currents reduces the temperature of those parts of the ocean through which they pass, and consequently also that of the superincumbent atmosphere, and thus causes the isothermals to deviate to the north of their normal positions. Thus an examination of all the principal deviations of the isothermal lines from their normal types leads to the conclusion that ocean-currents and the configuration of the great continents are the principal general causes which produce irregularities in the forms of those lines; and, moreover, a knowledge of these causes enables us to assign to the isothermals their approximate positions in any proposed hypothetical case in which the disposition of land and sea should be different from that which obtains at the present time.

The different hypothetical cases for which I shall endeavor to determine the isothermal lines are the following:—

(1.) The configuration of land and sea the same as at present, but without the Gulf-stream.

(2.) The Gulf-stream the same as at present, except that its progress into the North Sea is supposed to be arrested by a barrier of land, extending from the north of Scotland to Iceland and thence to the coast of Greenland.

(3.) The basin of the Atlantic from the Tropic to the North Sea converted into land, uniting the old and new continents.

(4.) Large portions of the continents of Europe and North America submerged beneath the surface of the ocean, and the Gulf-stream diverted into some other course.

The consideration of these cases will occupy the first Section of this part of the memoir.

10. The *snow-line*, or that line on the side of a mountain above which the snow never disappears at any season of the year, bears an important relation to glaciers, since it divides that higher region, in which productive agencies prevail in augmenting superficially the mass of a glacier, from the lower region, in which the destructive agencies predominate. It is essential to our investigations to know the vertical distance which existing glaciers usually descend beneath the snow-line, that we may be able to judge by analogy of the probable distances to which ancient glaciers may have descended.

As we ascend from the surface of the earth, the *mean annual temperature* decreases according to laws which have been approximately determined by observation. If this temperature, therefore, at any proposed place be greater than 32° F., we shall arrive at this latter temperature only at a certain elevation above the earth's surface. A line on the side of a mountain, or an imaginary line in space, along which the *mean annual temperature* is 32° F., I define as the *line of 32° F.* Its height can be approximately calculated for any place at which the mean annual temperature is known. In sufficiently low latitudes it will be at a considerable height above the earth's surface, but will descend to the surface along the *mean annual isothermal* of 32° F. as we proceed into higher latitudes. The relative heights of this line and of the snow-line at the present time depend on circumstances. It is essential to ascertain these circumstances and their influence, that we may be the better able to estimate the height of the snow-line in the hypothetical cases which I purpose to consider. We shall then be able, as intimated in the preceding paragraph, to estimate the height above the level of the sea to which the ancient glaciers may have descended. The second Section of this Part will be occupied with the consideration of these points. In the third and final Section I shall offer some observations on the relative claims of the different hypotheses of the first two Sections to form the foundation of geological theories.

§ I. *On the Positions of the Isothermal Lines in the above-mentioned hypothetical cases.*

11. Taking the first case, that of the absence of the Gulf-stream, let us trace the probable course of the January isothermal of 32° F. Proceeding from east to west, we observe that it attains its most southerly point on the high table-lands of south-

eastern Asia, proceeding thence with a little inclination towards the north until it has passed the Black Sea and arrived at the longitude of 20° E. As far as this point we may assume its position to be unaffected by the influence of the Atlantic waters warmed by the Gulf-stream. This influence, however, begins to show itself immediately to the west of the point above-mentioned, in the irregular and extensive deflection to the northward, which there begins to characterize this isothermal. This deflection is not entirely attributable to the Gulf-stream, for the Atlantic Ocean, independently of any warming currents, would undoubtedly produce some effect in lessening the winter cold of western Europe, and therefore produce northern inflections of the winter isothermals. Another reason for the more northern position of this line in western Europe than in southeastern Asia is the absence of that high table-land in the former region which characterizes the latter. To represent these influences, I have drawn the isothermal for our supposed case so as to continue to the coast the general northward direction which the actual line acquires about the 20th degree of longitude. This causes it to meet the Atlantic on the extreme western coast of Brittany. If we should draw the isothermal directly west from the meridian of 20° of long., it would cause the isothermal of about 24° F. to pass through that point of the coast through which the line of 32° F. passes as I have drawn it, so that 8° is thus allowed for the influence of the Atlantic Ocean, independently of the Gulf-stream, on the mean January temperature about these parts of the coast of western Europe. The actual temperature of the west coast of Brittany for January is about 42° F., instead of 32° F., as it would be in the absence of the Gulf-stream, according to the position of my imaginary isothermal for that case. I am, therefore, thus assigning an amount of 10° F. for the influence of the Gulf-stream on the January temperature of the coast of Brittany. The whole effect, therefore, of the Atlantic with the Gulf-stream on that coast is thus estimated at 18° F.

In traversing North America, the extensive mass of land to the north brings down the winter isothermals again to almost as low latitudes as in eastern Asia. The actual isothermal of 32° F. meets the American coast a little south of Philadelphia, and then pursues a very nearly western course until it reaches the meridian of about 106° W. long., where it begins to be affected by the Pacific Ocean and to deviate considerably to the northward. To complete my hypothetical line of 32° F., I join the point to which we have already traced it on the coast of Brittany with that at which the actual isothermal meets the coast of Philadelphia as just mentioned, the connecting line being slightly convex towards the north on the coast of Europe, and to the south on the coast of America, as is required by the continuity of its curvature. Across America, and to the west of it, the isothermal must manifestly be beyond the influence of the Gulf-stream, and our hypothetical line must consequently coincide with it.

It would appear from the existing isothermals, that the Gulf-stream produces little effect on the temperature, even in winter, on the eastern coast of America, as compared with its effect on the western coast of Europe. There are several causes which may be assigned for this difference. After the stream has passed the straits of Bahama, it passes into an ocean of which the temperature is not much inferior to its own, and more northerly its influence must be in some degree counteracted by the cold current proceeding southward through Davis's Straits. To the influence of these causes may be added that of the west winds which appear to prevail on the eastern coast of America as well as on the western coast of Europe. These, coming from the land in the former case, and from the ocean in the latter, tend to lower the winter temperature on the American, while they raise it on the European coast.

The deflection of the actual January isothermal of 32° to the northward on the western coast of N. America is considerably more rapid than that of my hypothetical line on the western coast of Europe. It also exceeds that of the lines of 41° and 50° more than any mere law of continuity would seem to require. A considerable portion of the deflection is attributable, I doubt not, to local causes. In fact, a considerable current is described as setting northward along that coast from about the 45th degree of latitude, which may probably account for this extra deviation. The remainder must be attributed to the influence of the Pacific Ocean, and would probably accord with the similar deflection which I have given to my hypothetical line as arising from a similar cause on the western coast of Europe.

Supposing the isothermal we have been considering to be correctly drawn for our hypothetical case, there can be no doubt, I conceive, of the approximate accuracy of the neighboring January isothermals as I have drawn them. In southern Asia they are compressed near to each other by the region of maximum cold which lies in the northeastern portion of Asia. As they approach the coast of western Europe they will necessarily become more dilated, as I have represented them.

12. Let us now examine the probable position of the isothermals for July in the hypothetical case of the non-existence of the Gulf-stream. These lines, it will be observed, as they now exist, have an extraordinary inflection to the north in northeastern Asia. As we proceed westward from that region, they take a direction considerably south of west, until they come under the influence of the anomalous temperatures of western Europe. This influence, however, does not sensibly extend so far southward in summer as in winter, on account of the higher temperature of the northern Atlantic in summer. The July isothermal

of 63°·5 F., which passes immediately south of London, seems not to feel it in any sensible degree. This isothermal, therefore, and all those to the south of it may be considered to have the same positions in our hypothetical case as in the existing one. Those immediately on the north of the isothermal of 63°·5 must necessarily be approximately parallel to it. We observe also, as these lines approach the coast of America, they suffer an anomalous deflection to the south, due, I imagine, to the polar current setting southwards along that coast from Davis's Straits, the warm season being that in which this cold current would be most felt. I have drawn the isothermals for our supposed case, as independent of these anomalous deviations, and such as their actual positions on the east and west of the region of these irregular influences obviously indicate. It would hence appear, that the Gulf-stream has no sensible influence on the July temperature of London, or of places in western Europe further to the south.

13. We are now prepared to estimate the effect produced by the Gulf-stream on the *mean annual temperature* of any assigned place. The following are the approximate numerical values of the temperatures for January and July, and the mean annual temperature, considered as the mean of those two temperatures, for the Alps, Snowdon, the northern extremity of Scotland, and center of Iceland; both for the present time, and for our hypothetical case, in which, it will be recollected, the configuration of land and sea is supposed to be the same as at present, but the Gulf-stream not to exist. The temperatures are all determined by Dove's map.

	At present, with the Gulf Stream.	Difference.	Without the Gulf Stream.	Difference.
THE ALPS.				
Temperature for January, . .	38° F.	35°	34° F.	39°
" " July, ...	73		73	
Mean annual temperature, . .	55·5		53·5	
SNOWDON.				
Temperature for January, . .	38 F.	23	23 F.	38
" " July, . . .	61		61	
Mean annual temperature, . .	49·5		42	
NORTHERN EXTREMITY OF SCOTLAND.				
Temperature for January, . .	36·5 F.	19·5	12 F.	44
" " July, ...	56		56	
Mean annual temperature, . .	46·25		34	
CENTRE OF ICELAND.				
Temperature for January, . .	30 F.	22	–4 F.	50
" " July, ...	52		46	
Mean, ...	41		21	
Mean annual temperature,* . .	39			

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* This is deduced from the mean of the monthly temperatures. The mean annual temperatures above given for the other cases is almost identical with those deduced from the monthly temperatures. The discrepancy of 3° in the case of Iceland may be attributed to local peculiarities.

14. The next case I have proposed for discussion is that in which the Gulf-stream should exist, with a barrier of land connecting Scotland with Iceland, and that island with Greenland. Since this barrier would intercept the influx of the Gulf-stream into the North Sea, it would very much reduce the temperature there, and in all the northern parts of Scandinavia. On the other hand, the waters of the Gulf-stream, being now confined to the northern part of the Atlantic, would considerably raise the temperature of that region. According to our preceding estimate, the present increase of mean annual temperature due to the Gulf-stream is as follows:—

18° F.	in Iceland;	7°·5 F.	at Snowdon;
12°·25 F.	in the north of Scotland;	3° F.	at the Alps.

The mean annual temperature on the south coast of Iceland is now about 40°. It is, I think, probable that this might be raised by 4° or 5° in the case supposed, which would make it approximate to the mean annual temperature of the English Channel. This effect on the mean temperature would be due principally to the effect on the winter temperature. If this latter were increased 6° or 7°, and the summer temperature 2° or 3°, the January temperature would be nearly uniform (or the January isothermal would run nearly north and south) from Iceland to the latitude of the Alps or central France. The January isothermal of 32° now runs north and south through an equal extent of latitude from a point several degrees north of the Arctic circle to the southern shore of the German Ocean. On the north of the barrier, on the contrary, the variation of temperature would be more rapid than at present.

15. The next supposed case is that in which the whole Atlantic, from the equator northward to Greenland, Iceland and the North Cape, should be converted into land. In this case there would be no reason why the isothermals should not preserve their parallelism, with the exception of merely local deviations, from points near the east coast of Asia to corresponding points near the west coast of North America. Let us first consider the January isothermal of 32° F. in the northern hemisphere.

If we take this line as drawn independently of the disturbing influence of the Gulf-stream, but supposing the Atlantic still to exist, it is characterized by a northward inflection as it approaches the Atlantic, due to the influence of that ocean. In the present case there is no reason for that inflection, and we may assume the isothermal to pass nearly in a straight line from the Black Sea to the point where the actual isothermal of 32° F. meets the coast of America. This will render its course nearly a straight line between the opposite coast of the single continent into which the two existing continents would be united in the case we are considering. Its course would be very nearly, but not exactly, east and west, reaching a rather lower attitude in Asia than in America, in consequence of the high tablelands of southeastern Asia.

The three succeeding existing isothermals to the north on Dove's map (those for 23°, 14°, and 5° F.) are very nearly parallel to that of 32°, and equidistant from each other through about 80° of long. in Asia, and through 30° of long. in N. America. In the intermediate space they are inflected to the north by the Atlantic. Their position in our present hypothetical case would doubtless be approximately determined by substituting straight lines across this intermediate space, for the actual inflected lines.

The present winter isothermals, north of those just mentioned, become more irregular in their course in eastern Asia, as well as in North America. In the former region the distance of successive lines from each other is somewhat less than in the latter, owing to the unsymmetrical position of the region of maximum cold, which, instead of being symmetrically situated round the north pole, inclines considerably towards north-eastern Asia. This position must be due, in great measure, I conceive, to the influence of the North Sea, warmed as it is by the Gulf-stream. In our hypothetical case this cause would be removed, and we may conclude that the region of maximum cold would be situated nearly symmetrically with reference to our one great continent, but inclined from the pole towards that continent, and from the great Pacific Ocean situated on the opposite side of the pole. The probable longitude of its central point would be nearly that of the present western coast of Europe. This would bring the isothermals in our hypothetical case, lying on the north of those already traced, into approximate parallelism with the equator between the eastern coast of Asia and the western coast of America. The distances between them (for such, at least, as should not be too far to the north) would necessarily be much the same as between those of which the positions have been previously discussed—the isothermals of 32°, and the three succeeding it to the north.

The approximate positions of the winter isothermals on the south of that of 32°, and in the northern hemisphere, may be easily inferred in like manner. It is not necessary here to discuss them in detail.

Let us now take the July isothermals for the northern hemisphere. In Asia there would seem to be no reason why they should differ materially in the present case from the actually existing lines. West of the meridian of 60° E. the two lines of 36°·5 and 41°, delineated on Dove's map, are manifestly affected by the Gulf-stream. The next to the south, that of 45°·5, together with the two succeeding lines, follow the inflection of the northern coast of Scandinavia, and must be considered as influenced in a small degree by the same cause. If we place them a little more southward, but still allowing for the tendency of the slight northern projection of the continent in that region to inflect these summer isothermals to the north, their positions will be approximately correct for our supposed case. Further west we must destroy the southward inflections produced by the Atlantic, and continue the isothermals almost directly west to the most northern points through which the existing ones pass respectively in the northwestern part of N. America, about the meridian of 130° or 140° of W. long.

Again, the isothermal still more to the south may be considered as unaffected by the filling up of the Atlantic, at the points at which they meet the meridians of 60° E. long. (that of the Ural Mountains,) and at those of 100° to 120° W. long. Straight lines joining these respectively would represent the isothermals of the intermediate space independently of merely local variations.

Taking the same places as before, we have the following results in the case before us for their temperatures :—

	At present.	Difference.	Old and New Continents united.	Difference.
THE ALPS.				
Temperature for January, . .	38° F.	35°	14° F.	61°
" " July, . . .	73		75	
Mean annual temperature, . .	55·5		44·5	
SNOWDON.				
Temperature for January, . .	38 F.	23	-7 F.	73·5
" " July, . . .	61		66·5	
Mean annual temperature, . .	49·5		29·75	
NORTHERN EXTREMITY OF SCOTLAND.				
Temperature for January, . .	36·5 F.	19·5	-22 F.	84
" " July, . . .	56		62	
Mean annual temperature, . .	46·25		20	
CENTRE OF ICELAND.				
Temperature for January, . .	30 F.	22	-25 F.	78
" " July, . . .	52		53	
Mean annual temperature (deduced from the monthly temperatures),	39		14	

The isothermal of 32° F. would pass nearly through Madrid. The whole climate of western Europe would be converted into an extreme continental climate similar to that of northeastern Asia at present.

16. The last hypothetical case I propose to consider is that in which all the lower land of Europe should be submerged beneath the surface of the ocean. This tract would comprise all northern Europe except the mountainous parts of Scandinavia; nearly the

whole of Russia in Europe, extending southward to the Black Sea; together with Central and Western Europe as far as the Pyrenees, the Alps, and the Carpathian Mountains, except those limited ranges of higher land which might still protrude as islands above the surface of the ocean. This space is intended to include all that over which the sea of the period of the Northern Drift must once have extended (supposing the drift to be of submarine origin,) together with such further extension southward as may be rendered probable by the cofiguration of the existing surface of the land. I shall also assume the entire absence of the Gulf-stream. I shall consider hereafter the manner in which this great current may have been arrested, or diverted from its present course.

In discussing the positions of the isothermal lines for the northern hemisphere in this case, we may again commence with the January line of 32° F. There appears no cause for any material alteration in its position in southern Asia east of the meridian of about the 70th degree of longitude. To the west of that meridian the influence of the ocean extending to the Black and Caspian Seas would doubtless begin to deflect it towards the north, and probably somewhat more than I have supposed it to be inflected by the Atlantic, independently of the effect of the Gulf-stream. From the 30th or 40th degree of east longtitude it would proceed nearly west, but with a slight deflection to the south, arising from the influence of the land which we may suppose still to exist in Scandinavia, and also from that of the northern continent of Greenland. This would cause the isothermal to intersect the line of the existing French coast about its northwestern extremity, the point at which I have before supposed it to be intersected by the line of 32° F. in the absence of the Gulf-stream. In the region of North America the isothermal would depend on the manner in which the Gulf-stream should be diverted from its present course. The neighboring isothermals would follow the course of that of 32° with approximate parallelism. The July isothermals, which should traverse the sea that we are now supposing to extend nearly as far east as the Ural Mountains, would be deflected southward as they are at present on approaching the shores of western Europe. It will be observed that the July isothermal of 63°·5 intersects the January one of 32° (as I have drawn them for the case previously considered of the absence of the Gulf-stream) at a point very near the extreme western coast of Brittany (§ 11, p. 74.) Between this point and the meridian of the Ural Mountains, the January line would lie more to the north and the July one more to the south, by the influence of the extended ocean. The effect, therefore, would be to equalize in a greater degree than at present the summer and winter temperatures of the tract in the vicinity of the European portions of these lines, but probably without producing any material changes in its mean annual temperature. This tract may be considered as comprising the whole of Central Europe, together with its western portion from the Pyrenees to the southern shores of the Baltic. It is the region in which the geologist is more especially interested in tracing the climatal influences of changes in the configuration of the earth's surface. I shall therefore endeavor to ascertain from more general considerations the probable effect of an extended ocean on the *winter*, the *summer*, and the *mean annual temperatures* of the region in question.

17. For this purpose I have deduced from Dove's map the following results respecting these temperatures for the 20th, 30th, 40th and 50th parallels of latitude in both hemispheres. Each result given for January is the mean of the January temperatures for all places situated under the corresponding parallel of latitude; and each result for July is a similar mean for the July temperatures. The mean of these is assumed to be the approximate value of the mean annual temperature of the different parallels respectively:

Mean Annual Temperatures of different Parallels of Latitude.

Lat.=20° N.		Diff.	Lat.=20° S.		Diff.
January mean temp.	68 F.	14°	January mean temp.	78 F.	9°
July " "	82		July " "	71	
Mean annual temp.	75		Mean annual temp.	74·5	
Lat.=30° N.			Lat.=30° S.		
January mean temp.	58 F.	20°	January mean temp.	75 F.	12°
July " "	78		July " "	63	
Mean annual temp.	68		Mean annual temp.	69	
Lat.=40° N.			Lat.=40° S.		
January mean temp.	37 F.	35°	January mean temp.	58 F.	9°
July " "	72		July " "	49	
Mean annual temp.	54·5		Mean annual temp.	53·5	
Lat.=50° N.			FALKLAND ISLANDS.* Lat.=50° S.		
January mean temp.	16 F.	46°	January mean temp.	34 F.	18°
July " "	62		July " "	52	
Mean annual temp.	39		Mean annual temp.	43	

We may first remark the striking equality of mean temperatures in corresponding parallels north and south of the equator as far as the 40th degree of latitude. The small differences indicated by the above numbers are not to be regarded, because they lie within the limits of error to which the numbers themselves must necessarily be subject. In the latitude of 50° N. the severe winter cold of Eastern Asia and that of the central portions of the North American continent reduce the mean temperature to more than 4°

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[*] The isothermal lines for this southern latitude on Dove's map are continued only for short distances to the E. and W. of the Falkland Islands, so that the temperatures here given must not be depended upon for the mean temperatures of the parallel of 50° S. They are probably not far wrong, on account of the great regularity of the neighboring isothermals.

lower than that of the Falkland Islands in 50° S. latitude. But there are only a few observations recorded either of the January or the July temperatures along that southern parallel.

There is, on the contrary, a striking contrast between the northern and southern hemispheres with respect to the difference of summer and winter temperatures. These differences are in all cases considerably greater, and in the higher latitudes much greater, in the northern than in the southern hemisphere.

From these results it would appear, that the greater or less extent of land or sea has very little effect upon the mean annual temperature of an entire parallel of latitudes from the equator to about 45° degrees of latitude; and that beyond that parallel the predominance of land diminishes, while that of sea increases the mean annual temperature. Also, that a predominance of sea, in all cases, but especially in the higher latitudes, produces a greater equality of summer and winter temperatures.

18. Again, let us compare the temperatures of different stations along the same parallel of latitude, some of these stations being centrally situated as regards the continents, and others as regards the sea. It should here be remarked that the temperatures of the stations in the Atlantic for the 40th and 50th degrees of latitude must be regarded as partly hypothetical, because I have estimated them independently of the influence of the Gulf-stream. The following table embodies the results, deduced from Dove's map, for different stations on six parallels from that of 20° S lat. to that of 50° N. lat. inclusive:

Parallel of Latitude.	Longitude.	Temperature.			
		January.	July.	Difference.	Mean.
20° S. . .	23° E. Land, . .	78° F.	71° F.	7° F.	74·5° F.
	20 W. Sea, . . .	74·5	67	7·5	70·75
	56 W. Land, . .	78	68	10	73
	140 W. Sea, . . .	77	74	3	75·5
10° S. . .	23 E. Land, . .	78	75	3	76·5
	20 W. Sea, . . .	77	74	3	75·5
	56 W. Land, . .	73	75	3	76·5
	140 W. Sea, . . .	78	77	1	77·5
20° N. . .	30 E. Land, . .	65	91	26	78
	40 W. Sea, . . .	71	76	5	73·5
	150 W. Sea, . . .	71	78·5	7·5	74·75
30° N. . .	30 E. Land, . .	56	81·5	25·5	68·75
	40 W. Sea, . . .	59	73	14	66·25
	150 W. Sea, . . .	62	72·5	10·5	67·25
40° N. . .	48 E. Land, . .	32	79	47	55·5
	40 W. Sea, . . .	44	68	24	56
	90 W. Land, . .	31	75	44	53
	170 W. Sea, . . .	54	59	5	56·5
50° N. . .	80 E. Land, . .	0	71	71	35·5
	30 W. Sea, . . .	26	61	35	43·5
	90 W. Land, . .	0	61	61	30·5
	150 W. Sea, . . .	35	53	18	44

On examining this table, we remark that in latitude 20° N. or 20° S., the mean of the temperatures of the land stations exceeds the mean of the sea stations; and in latitude 30° N. there is a similar small excess. In latitude 40° N. there is no sensible excess, and in latitude 50° N. the mean of the two land stations is about 10° less than that of the sea stations. It would thus appear that the effect of continents within the first 40° of latitude has the effect of increasing slightly the mean annual temperature of the most central parts of such continents, although it would appear from the previous table (§ 17, p. 82) that the existence of such continents within the above latitude has no appreciable effect in elevating the mean annual temperature of the whole parallel. The depression of the mean annual temperature at the land stations, compared with that of the sea station, in latitude 50°, is large. We might hence be led to conclude that a diminution of land and increase of sea along that parallel, such as would result from the depression of Europe beneath the ocean, would be attended with a considerable increase in mean annual temperature in the region thus become sea. This effect however would be very different in different continental regions along the same parallel. The effect would be greatest in the most central parts of the continent, and least in the vicinity of its bounding shores. To find the effect of the submersion of Europe, we may compare the mean annual temperatures at the two sea stations already given on the parallel of 50° with two other land stations on that parallel, one in western Europe (long. 10° E.,) and another in eastern Europe (long. 30° E.) The temperatures of these stations (assuming always the absence of the Gulf-stream) will be—

	Long 10° E.	Diff.	Long. 30° E.	Diff.
January temperature, ...	25°	40°	14°	54°
July temperatue, ...	65		68	
Mean, ...	45		41	

The mean of 45° and 41° is 43°, which is not 1° less than the mean of the two sea stations of the same latitude. This tends to prove that the conversion of Europe into sea would have little effect on the mean annual temperature of those portions of it which lie contiguous to the parallel of 50° latitude, and especially in western Europe, the region, for instance, lying between the parallels of the Alps and the southern shores of the Baltic. At the same time the winter temperature would be increased and that of summer diminished to an equal amount, since their mean remains the same. If we suppose the change in each of these temperatures to be 4° for the station above-mentioned (long. 10° E.), we shall have for that station,—

		Diff.
January temperature, ...	29°	32°
July "	61	
Mean, ...	45	

At Snowdon, from its greater proximity to the ocean, this change in the summer and winter temperatures will be less. If we suppose it to be 2°, we shall then have for Snowdon (see Table, § 13, p. 77,)—

		Diff.
January temperature,	25°	34°
July “	59	
Mean,	42	

This latter mean annual temperature is about 2° higher than that of the south coast of Iceland (see Table, § 13, p. 77.) The difference of summer and winter temperatures, 34°, is greater than for Iceland, where it may be stated generally to be about 18° or 20° only. This actual case, however, presents a good standard of comparison for our hypothetical case. The Falkland Islands, situated in lat. 50° S., and the island of S. Georgia, in lat. 54° S., furnish also good standards of comparison. The conditions of the station above mentioned in western Europe (long. 10° E.), and Snowdon, of which the latitude is 53° N., would, in the case we are discussing (that of the absence of the Gulf-stream, and the submersion of Europe), far more resemble the actual conditions of all the above places than they do at the present time. We have for the Falkland Islands,—

		Diff.
January temperature,	52°	18°
July “	34	
Mean,	43	

This is less by 2° than the estimated mean temperature for the corresponding place (long. 10° E.) in N. lat.; the difference between the winter and summer temperatures is here less by 16° than in the other case. Again, we have for the island of S. Georgia (lat. 54°),—

		Diff.
January temperature,	45°	14°
July[*] “	31	
Mean,	38	

Here the mean temperature is 4° less than the estimated mean temperature of Snowdon; and the approximation to uniformity of temperature throughout the year much greater.

The table given above (§ 17, p. 82) shows the tendency, as I have already remarked, of the predominance of sea to equalize the summer and winter temperatures; and this is in accordance with the fact that there is a greater equality of those temperatures in the Falkland Islands and S. Georgia, than in the corresponding north-

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[*] This temperature is not very certain, even should the map be exact, since there is no July isothermal given in the southern hemisphere quite so far south as South Georgia.

ern latitudes. It also appears from the table just referred to, that for the latitudes there given above 40°, the mean temperature for a whole parallel of latitude is higher in the south than for the corresponding parallel in north latitude. Now if this be due to the predominance of sea in the southern, and of land in the northern hemisphere, it would appear that the mean annual temperature of a *sea* station on the parallel of 50° N. latitude, would not exceed that of a similar sea station in equal S. latitude, unless the temperatures should be materially influenced by local causes. Hence the lower temperature of the Falkland Islands, as compared with that of the corresponding northern parallel, must be due either to local influences, or to too high an estimate of the mean annual temperature in western Europe in the hypothetical case of the absence of the Gulf-stream. I am disposed to attribute it to the latter reason. The temperature of the Falkland Islands may be depressed by a southern continent not very distant from them, and by consequent accumulations of ice; but it would seem that the region of western Europe about the parallel of 50° would, in the absence of the Gulf-stream, be liable to an equal similar influence from the Scandinavian region. I am disposed, therefore, to think that the isothermal lines for this case, represented on the map, ought to meet the coast of western Europe at points rather more southerly, so as to indicate temperatures for each locality about 2° or 3° lower than those now indicated. I might have made this correction on the map, but, as the determination of the positions assigned to these isothermals was entirely independent of any comparison with places in the southern hemisphere, I have thought it better to allow them to remain, as a proof of the approximate accordance of results arrived at by independent considerations. These corrected positions of the isothermals would assign to Snowdon, in the absence of the Gulf-stream, a mean annual temperature of 39° or 40°.

19. In more northern latitudes than that of Snowdon, our foregoing reasoning would lead us to conclude that the mean annual temperature would be increased by the submergence of Europe, but only in a comparatively small degree for insular stations and those situated immediately on the shores of the Atlantic. The temperatures, therefore, of the northern extremity of Scotland and of Iceland, under our present hypothesis, may be taken somewhat greater than those given in the table of § 13, p. 77, for the case in which the absence of the Gulf-stream was assumed. The temperature of the Alps would probably differ little from that given in the same table. The correction mentioned in the preceding paragraph, if adopted, must, of course, be applied also to these temperatures.

(*To be continued.*)

Art. XIV.—*The Relations of Cells to the Physical and Teleological views of Organization;* by W. I. Burnett, M.D., Boston.

The cell is the fundamental unity of organized forms. It is the chosen material form through which organization gains its first expression. To use a metaphor, it is the only altar on which life and matter are married, to pursue together a common and definite end.

These premises being true, as all modern inquiry clearly proves, we can justly seek from a study of this cell, a manifestation of all the conditions of organization, as far as they are capable of being made evident through material forms. We can also expect, by a consideration of these conditions, to be able to comprehend the higher and ulterior relations of organization as occurring in permanent individual forms.

Two dissimilar views of the real nature of organization have been urged in modern times.

That the bearings of the subject in question may be fully understood, a brief description of both of these views is here required. The first is, that every individual organism exists in virtue of a predominant idea: this idea, therefore, preceded the organism, of which this last is the true material manifestation. Organisms are, therefore, if I may so express myself, the incarnations of preëxistent ideas in nature. An organized form is simply a colligation of molecules of plastic matter occurring under the direction of a determinate idea or force. This force must, it is evident, be peculiar and differing from any belonging to matter generally. It is an immaterial one, and can be likened to no other in nature with which we are acquainted. In its conception we should not confound it with our idea of life; for between them a broad distinction can be drawn.

Thus, our idea of life is necessarily connected with, and dependent upon, that of organization; because, from the limitations of experience, we have not, and cannot conceive of it as a distinct and separate entity. On the other hand, our conception of this determinate idea, or that of the *individuality* of organization, although involving some of the same data as that of life, occurs from relations sufficiently dissimilar, to show well its distinction. Thus, while our idea of life is only *coëxistent* with that of organization; our idea of this individuality is not only *coëxistent*, but necessarily preëxistent to it. We do not comprehend life except in conjunction with matter under peculiar forms; on the other hand we conceive of this determinate idea or individuality as existing before a trace of organization appears.

This view of organization, which widely separates the organic from the inorganic world, as we can comprehend each through the expression of their forces;—which gives an inherent dignity to individual existence, because there is always an end in view,—this view of organization, I repeat, is called the *teleological* one.

The other and second view is fundamentally different. Adopting it, one does not recognize that the forces of organized are more in number, or different in character from those of unorganized matter;—the fact of organization being due to a certain combination of powers possessed by all material forms. And when this combination has once taken place, there necessarily results, in virtue of it and the forces impressed on matter in its beginning, a certain end which is called individual existence. The common phenomena of organization, therefore, are due to the blind working of the laws of necessity, and which are irrespective of any purpose; they also involve no conditions excepting those properly belonging to Chemistry and Physics.

According to this view also, the so-called "individual adaptation" does not result from a determinate idea seeking an expression, but rather ensues from a combination of blind forces, which the Deity impressed upon matter in the beginning. Design in nature, therefore, is only another set of terms for necessity of physical condition. Again, when we see the habits and conformation of an animal *suited* to the circumstances under which it is found, we are not to attribute this to an idea preëxisting all, and thus seeking its material expression; but are to regard the whole in the light of a necessity; for the very fact of the existing state of conditions implies that, were they different, the animal would not exist; and therefore the very data we reason from, determine the idea of necessity as far as justly applicable to works of an almighty power.

This view of nature which ranges all its phenomena under the domain of physical forces, thus giving, in one sense, the same dignity to inorganic as to organic forms,—this view of organization, I repeat, is called the *physical* one.

In this brief description of these two widely dissimilar views of organization, I may have failed to express clearly the grounds of their distinction; for nothing is more difficult than the successful expression of the exact definitions of mere modalities of matter. In a laconic and perhaps comprehensive form, I would say that the *teleological* view is the full definition of *Development;* while the *physical* view is the equally full definition of *Combination.*

We will now turn to the arguments for and against each of these views, at least as far as dependent upon cell-studies.

The first question is, does the adaptation perceived in the organic, differ in character from that perceived in the inorganic world? An affirmative answer must, I think, be given to this question. The adaptation seen in the inorganic world has reference only to existing circumstances, and the only surety of its continuation is in the persistence of the forces on which it depends. Such, for instance, is that of the planetary system. It is properly called an adaptation only in virtue of the existing harmony found. But this harmony, however perfect, indicates no definite end, which is the final reason of its existence.

On the other hand, with organic nature, other and different relations are seen. For besides the adaptation just spoken of, and which conduces to its general harmony with matter, there is superadded an *individual* adaptation of the whole, for an end, seemingly in view from the beginning. Indeed, we can truly say with Kant, that this end constitutes the very definition of an organized form.

In all our investigations into the structure of animals and plants, we involuntarily (in one sense) proceed upon the principle that *nothing was made in vain.* If at any time we have even a misgiving of the whole truth of this principle, our scientific ardor, as hopeful of real results, is immediately relaxed, not to say harmed. This involuntary admission of a doctrine, shows how secretly yet how firmly is our mind, in its study of natural phenomena, linked with the *teleological* view of organization.[*] We cannot free ourselves from it, any more than we can free ourselves from the silent yet constant admission of the truth of the great physical doctrine that *nothing comes by chance.* This question, therefore, which I have put, might well seem not only superfluous, but highly unphilosophical. But I was led to commence with it from the fact that a very sagacious mind,[†] thinks it correctly answered in the negative. We will, however, pursue this subject a little farther. I have said that the adaptation of the inorganic world has reference to existing circumstances only, while that of the organic world beside being individual, has always reference to events or contingencies of the future. This point is well illustrated in the phenomena of reproduction.

When animals were first created, the footing on which they commenced life, was the same in each. But why, accepting the *physical* view of organization, were their powers of reproduction formed exactly in accordance with their probabilities and liabilities of existence, as all zoological experience constantly shows

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[*] I think it may be truly said that the strength and ever-constant presence of this principle in the minds of great naturalists, has been the grand secret of their success. That this is so the instances of many notable men, might be adduced. In the case of Cuvier this was preëminently true, and it served as an ever-faithful intuition to open to him domains of knowledge hitherto untrodden. There is another naturalist now living, whose splendid labors, as I know personally, have been based upon this same principle.

[†] Schwann, *Mikroscop. Untersuch.* &c., or Sydenham Soc. Ed., p. 187.

is true? It is the characteristic of physical forces that they act upon the conditions of the time, and no physical force can act on the probability of future contingencies. The amount of animal and vegetable life on the earth's surface, in localities not disturbed by human or other agencies of an accidental nature, has not changed for an indefinite period of time. In those places the mutual relations of animals and vegetables exist now as we have reason to believe they did in the beginning.

There is no evidence that there has hitherto been a constant oscillation, and that the present rest and harmony is one ultimately and necessarily gained. Now in all these animals and plants, we find their reproductive powers, the capacity of their organs of generation, exactly in accordance with their liabilities to destruction. Were this the place, the truth of this remark might be illustrated by many special instances. But it is evident that by this almost prescient adaptation, the numerical relations of species are preserved unchanged; and those who are familiar with the leading results of zoological research at the present day, can scarcely entertain this subject in the light of a question.

The next point of discussion is, whether, admitting organization to exist always in virtue of determinate ideas, it is not unphysical and unphilosophical to assert, as we must, that these ideas or peculiar forces exist previous to the material forms in which they are ultimately expressed? This question is so specious that at first an affirmative answer appears to be the only correct one. But a little consideration will, I think, show its error. Our knowledge of physical phenomena is derivable from observation only; and when points are urged upon us which we have not observed, and which also do not seem compatible with hitherto existing observation, they are liable to be pronounced unphysical. But the history of any of the inductive sciences has shown that the singularity of any hypothesis or opinion, concerning physical phenomena, is no *a priori* argument against its truth. This remark is aptly true of the present case. The hypothesis that matter should have determinate ideas not expressed by physical phenomena at the time, but which are latent, and are to be developed under special forms in future, this hypothesis, I repeat, should not be rejected on the ground alone of its singularity; and much more will it be admissible if its singularity can be disproved. This disproval may be found, I think, in the numerous analogous phenomena of generation. Here we are driven to the admission of the existence of forces, long before the formation of the material organs, in which they ultimately find their expression.

Take, for instance, the *cicatricula* of a robin, and that also of a hawk; physically they resemble each other exactly, and no microscopical analysis can detect between them any material difference. Yet no one will pretend to deny that in the one lies concealed all that belonging to a robin, and in the other all that belonging to a hawk. This will bear no other interpretation. Here you have very dissimilar powers and forces in apparently identical material forms; and unless we declare that these different powers and forces existed before and aside from the material form, instead of gradually accruing to it, as a particular character was assumed, we shall be at a loss to account for the certainty and uniformity of result in every case. Again, the primordial material condition of every animal is a nucleated cell, which in every case has exactly the same physical aspect. Now in its growth to the perfect form, the new material constantly added is is extraneous, and there would appear no reason why it should always suit the conditions of the case, were there not an underlying, preëxisting idea. Indeed we might expect an occasional blending of dissimilar forms. But this never occurs, and few points connected with organization have been more positively determined, than the distinct, unchanging individuality of animal and vegetable types.

If this point needs further illustration, or even that which is better, we can find such in the male phenomena of generation. It may be well to discuss briefly a few of these points.

Within a few years, three prominent facts have been satisfactorily established concerning the function of the spermatic particles. These are, 1st, That they are the only fecundating particles of the semen. 2nd, That a single individual particle is sufficient to fecundate a single ovum. 3rd. That the physical phenomena of fecundation are those of simple contact alone, of the spermatic particle with the ovum; there being no material loss on the part of the former.

We know very well how important and active a part the male plays in the production of the new being, and I scarcely need add that the offspring partakes equally of the physical peculiarities of both parents. But in no way can it receive those of the father except through the medium of the spermatic particles. And so, however strange it may appear at first, yet the conclusion is irresistible, that a single spermatic particle must contain, concealed within it, not only the general physical peculiarities of the father, but mental dispositions also, and as is too often true of our own species, morbid taints superadded to all.

The third and last point in the discussion of this subject, is the objection to the teleological view of organization urged by Schwann,* and that too, concerning the general phenomena of the subject we have just left—generation. I will quote the entire passage that there may be no misapprehension of the idea in-

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* Loc. citat., Syd. Soc. 2d., p. 189.

tended to be conveyed. He says: "If we assume each organism to be formed by a power which acts according to a certain predominant idea, a portion of this power may certainly reside in the ovum during generation; but then we must ascribe to this subdivision of the original power, at the separation of the ovum from the body of the mother, the capability of producing an organism similar to that which the power, of which it is but a portion, produced: that is, we must assume that this power is infinitely divisible, and yet that each part may perform the same actions as the whole power. If on the other hand the power of organized bodies resides, like the physical powers, in matter as such, and be set free only by a certain combination of molecules, as for instance electricity is set free by the combination of a zinc and copper plate, then also by the conjunction of molecules to form an ovum the power may be set free, by which the ovum is capable of appropriating to itself fresh molecules, and these newly-conjoined molecules again by this mode of combination acquire the same power to assimilate fresh molecules." Schwann is here evidently urging the doctrine of catalysis in organic forms. This same doctrine has lately been pushed to its limit for similar reasons, by Mulder.*

And thus it would appear that some, in the study of organic phenomena, are willing, rather than appear what they call "unphysical," to summon to their aid the blindest physical forces, instead of admitting the existence of those which are special and distinct, and constantly urged upon them. The prominent objection Schwann urges, is the physical absurdity that the division of a power or force does not decrease it.

But this is falling back upon the properties of physical forms only, in which the mathematical axiom that *a part is less than the whole* is true. But it is the peculiarity of immaterial agents that they cannot be subject to the same definitions as those of a material nature. We have yet to escape from a strange confusion of ideas on these points, and when considering these higher forces, we must not tacitly deny their higher and immaterial character, by subjecting them to material definitions. For, on these grounds, the very existence of that of which we feel most certain, namely, *thought*, might well be denied. In fact, I think many of us have yet to learn that the mathematical axiom above quoted, holds true of the immaterial agents.

Perhaps this remark is true even of electricity, for in the phenomena of ***catalysis***, we witness the transference of force or quality without an apparent loss from the body, from which the

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* The Chemistry of Vegetable and Animal Physiology. English Trans. Edinb., 1849, pp. 28, et. seq.

transference takes place.[*] To urge that that only which is substantial can be transferred, is to reason on the ground that a phenomenon in nature is impossible because it eludes our observation and analysis.

In the phenomena of generation we certainly have proved to us that there may be a division of power or quality without a real loss; in other words that there may be an indefinite number of divisions and yet each of these possess the capability of the whole from which the division was taken or made.

Thus, as I have before said, the spermatic particle is the potential representative of the whole male being. It contains within it the totality of the peculiarities of the individual in which it has been formed. These spermatic particles are constantly formed, and in the case of any of the higher animals, literally millions are yearly evolved; yet each possesses the powers of the other, and of the whole animal: and the animal certainly loses none of its individuality by such a constant division.

The objections of Schwann, to the teleological view of organization, are therefore, more specious than valid, because the reality of the very conditions objected to has an expression in quite common phenomena.

These same teleological views might be shown to be almost imperatively forced upon us by a general review of developments imperfectly attained,—the subject of monstrosities. Here you not unfrequently have conditions of organization, in which imperfections of physical form, reveal distinctly the perfection of the underlying determinate idea of organization.

In special cell studies connected with the subject of generation, however, as we have seen, these doctrines of teleology find their most unequivocal support.[†]

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[*] In regard to this point, Mulder (Loc. cit.) takes a different view. He thinks that in the case of a magnet magnetizing a piece of iron, there is no *transmission* of force, but simply an awakening of slumbering forces in the iron. It might well be asked if this makes the matter any more clear? You are obliged on this supposition to admit the existence of *latent forces* in the iron. and this is "unphysical" according to his own admission. Mulder says, "A weak force is strengthened; it is impossible to imagine the transference of a force from one material mass to another." But, is it not truly "unphysical" to suppose that a weak force can be strengthened except by the *addition* of new force?

[†] It may be urged that in all cases it conduces much more to the object of science to strive, at least, to adopt the *physical* instead of the *teleological* explanation of the phenomena of organic life. This is so because it leads us in our investigations rigorously to exclude the admission of those various hypothetical forces and conditions, which ultimately serve as an universal refuge in the instances of inexplicable phenomena. On the other hand, if we seek to base all phenomena on physical grounds, we tend to exclude the admission of conditions not having their corresponding expression in physical forms. This objection therefore rests rather upon our liability to error in interpreting natural phenomena, than upon real grounds. It must be regarded in the light of a necessary *caveat* connected with the fallibility of our intellect. There is, however, as we have seen, a danger, that in endeavoring to be strictly *physical* we may become highly "unphysical," not to say unphilosophical.

In conclusion, I think it may be truly said that one of the tendencies of the most intimate physiological, microscopical studies of the present day, is to show the inadequacy of microscopic and chemical investigations to detect physical differences in structures essentially dissimilar. Once appreciating this fully, we are prepared for the ulterior doctrine, that in organization, matter is but the vehicle for the phenomenal manifestation of determinate ideas, which last only, therefore, have an objective reality.

ART. XV.—*A Method of getting rid of Sal-ammoniac in Analysis;* by DR. J. LAWRENCE SMITH.

THERE is nothing in mineral analyses more embarrassing than the accumulation of sal-ammoniac towards the end of an analysis, especially where potash and soda are to be estimated. The only method now adopted to get rid of this ammoniacal salt, is to volatilize it by heat, which, if the quantity be considerable, is attended with no little annoyance, and a certain loss of more or less of the fixed alkalies which may be present. I have within the last twelve months discovered a method of overcoming that difficulty, and much experience during that time has proved that it is of considerable value. The method is simply to add nitric acid to the solution containing the sal-ammoniac and alkalies, and heat it gently over a lamp or sandbath in a glass flask or porcelain capsule. The nitric acid may be added either before the liquid is concentrated or after concentration; a most quiet decomposition ensues, and the liquid readily evaporates to dryness leaving nothing but the fixed alkalies if they be present. I am in the habit of using a little more than three grammes of pure nitric acid of ordinary strength to every gramme of sal-ammoniac supposed to be present in the liquid. The exact nature of the decomposition which ensues cannot now be stated, but there is doubtless formed besides other things—chlorine, hyponitric acid and nitrogen. I shall not enter more into detail about this method, as I intend at a future time to do this; only wishing at present to take precedent in what I presume a method of some importance in analytical chemistry and never to have been used before for this end.

Art. XVI.—*Description of a Brown Coal Deposit in Brandon, Vermont, with an attempt to determine the Geological Age of the principal Hematite Ore Beds in the United States;* by Edward Hitchcock, D.D., LL.D., President of Amherst College, and Professor of Geology.

In the autumn of 1851, Professor Shedd of Burlington, presented me with a few specimens of beautifully preserved fruits from Brandon, Vermont. They were converted into Brown Coal, and retained exactly their original shape and markings. Early in the spring of 1852, I visited Brandon, and found that the fruits were obtained from a bed of Brown Coal connected with the white clays and brown hematite of that place. I perceived at once that an interesting field was open before me; and ever since I have been endeavoring to explore it. Great difficulties presented themselves; and I have resorted to several gentlemen, both in this country and in Europe, for aid. Their opinion has yet been obtained only in part. But there are several points of much interest to American geology, cleared up by what I have already ascertained. I have concluded, therefore, to give a brief account of this case; hoping hereafter to make additions to it.

I would here acknowledge my deep indebtedness to John Howe, Jr., the proprietor of this deposit of iron, clay, and brown coal. Not only did he do all in his power to aid my investigations upon the spot last spring; but since then he has sent me, free of expense, numerous specimens of the fruits and the coal; especially at one time two barrels of the coal containing the fruits, and at another time, a gigantic mass of lignite,—the trunk of a large tree in fact, which is now deposited in the cabinet of Amherst College.

I shall first give a description of the topography and geological associations of this carbonaceous deposit: next an account of the lignites and fossil fruits; and finally deduce from the facts some geological inferences of importance.

I. *Topography and Geological Associations.*

Geologists are aware that along the west base of the Green and Hoosac Mountains from Canada to New York occur numerous beds of brown compact and fibrous hematite iron ore. That in Brandon lies between two and three miles east of the village. Passing easterly from the village, the surface rises slightly, and exhibits clay, drift, and limestone rock in place. According to my measurements with the aneroid barometer, Brandon village is 465 feet above the ocean, and the iron mine 520 feet above the same. A short distance east of the mine, the Green Mountains rise rapidly.

At this spot we find the following varieties of substances in juxtaposition:

1. Beautiful kaolin and clays colored yellow by ochre, rose-color by manganese, (?) and dark by carbon.
2. Brown hematite and yellow ochre.
3. Ores of manganese.
4. Brown coal.
5. Beds of gravel connected with the clays.
6. Drift, overlying the whole.
7. Yellowish limestone, underlying the whole.

The position of the clays it is difficult to determine exactly, as there seems to have been a good deal of disturbance of the strata, perhaps only the result of slides. The iron is generally found beneath the clay, as is also the manganese. The coal in a few places shows itself at the surface. In one spot a shaft has been carried through it, only a few feet below the surface, and the same has been done to the same bed nearly 100 feet below the surface. In both places it is about twenty feet thick. I found it to be the conviction of the miners that this mass of coal forms a square column of that thickness, descending almost perpendicularly into the earth, in the midst of the clay. My own impression was, that it is a portion of an extensive bed, having a dip very large towards the northwest; perhaps separated from other portions of the bed by some disturbance of the strata. But I found great difficulty in tracing out its exact position.

It ought to be mentioned that no unstratified or igneous rocks are known to exist in the vicinity of these deposits; nor do they exhibit any marks of the metamorphic action of heat.

II. *Coal, Lignite and Fossil Fruits.*

The greater part of the carbon of this deposit is in a condition intermediate between that of peat and bituminous coal. It is of a deep brown color, and nearly every trace of organic structure, save in the lignite and the fruits, is obliterated. Disseminated through it are numerous angular grains, mostly of white quartz, rarely exceeding a pea in size. It burns with great facility with a moderate draught, and emits a bright yellow flame, but without bituminous odor. After the flame has subsided, the ignited coals gradually consume away, leaving, of course, a quantity of ashes. It is employed to great advantage in driving the steam engine at the works; and I should think it might be used advantageously for fuel in a region where wood is scarce, which is not the case at Brandon.

Interspersed through the carbonaceous mass above described, occur numerous masses of lignite. In all cases which have fallen under my observation, they are broken portions of the stems or branches of shrubs and trees, varying in size from that of a few lines to a foot and a half in diameter. They all appear to me to have been drift wood. The largest mass which I have seen, and to which I have already referred as sent me by Mr. Howe, resembles exceedingly a battered piece of flood-wood; which led Mr. Howe humourously to inscribe upon the box in which it was sent, "*A piece of flood-wood from Noah's Ark.*"

This lignite in all cases retains and exhibits upon a fresh fracture, its organic structure. Yet generally it is quite brittle, and when broken across the fibres it has the aspect of very compact coal, which admits of a good polish. In some specimens the original toughness of the wood is not quite lost, and the aspect of the wood remains.

The large mass of which I have already spoken, as now in the cabinet of Amherst College, is four feet long and sixteen inches in its largest diameter. It is considerably flattened, but seems to have been so originally. In the peaty matter that adheres to it, I noticed several specimens of fruit, and more than one species.

With perhaps one or two exceptions, all the lignite of this deposit belongs to the exogenous or dicotyledonous class of plants. In general the texture is close, and some of the wood is very fine grained and heavy. The bark is often quite distinct. I have been inclined to refer some of the wood to the maple; yet probably a good deal of it is coniferous: but my microscopic examinations on this point have not been as satisfactory as I could wish. I do not think much of the wood belongs to the pine tribe now common in this latitude. I have placed specimens in the hands of several distinguished vegetable physiologists, and had hoped ere this to learn their opinion; but they have not yet given it.

The fruits and seeds of this deposit are the most interesting of the relics found in it. But they are even more perplexing than the lignite. As yet I hardly dare venture to refer any of them to living or fossil genera known to me. I shall, therefore, merely present figures of the principal distinct forms which I have obtained, and leave a minute description to some future occasion.

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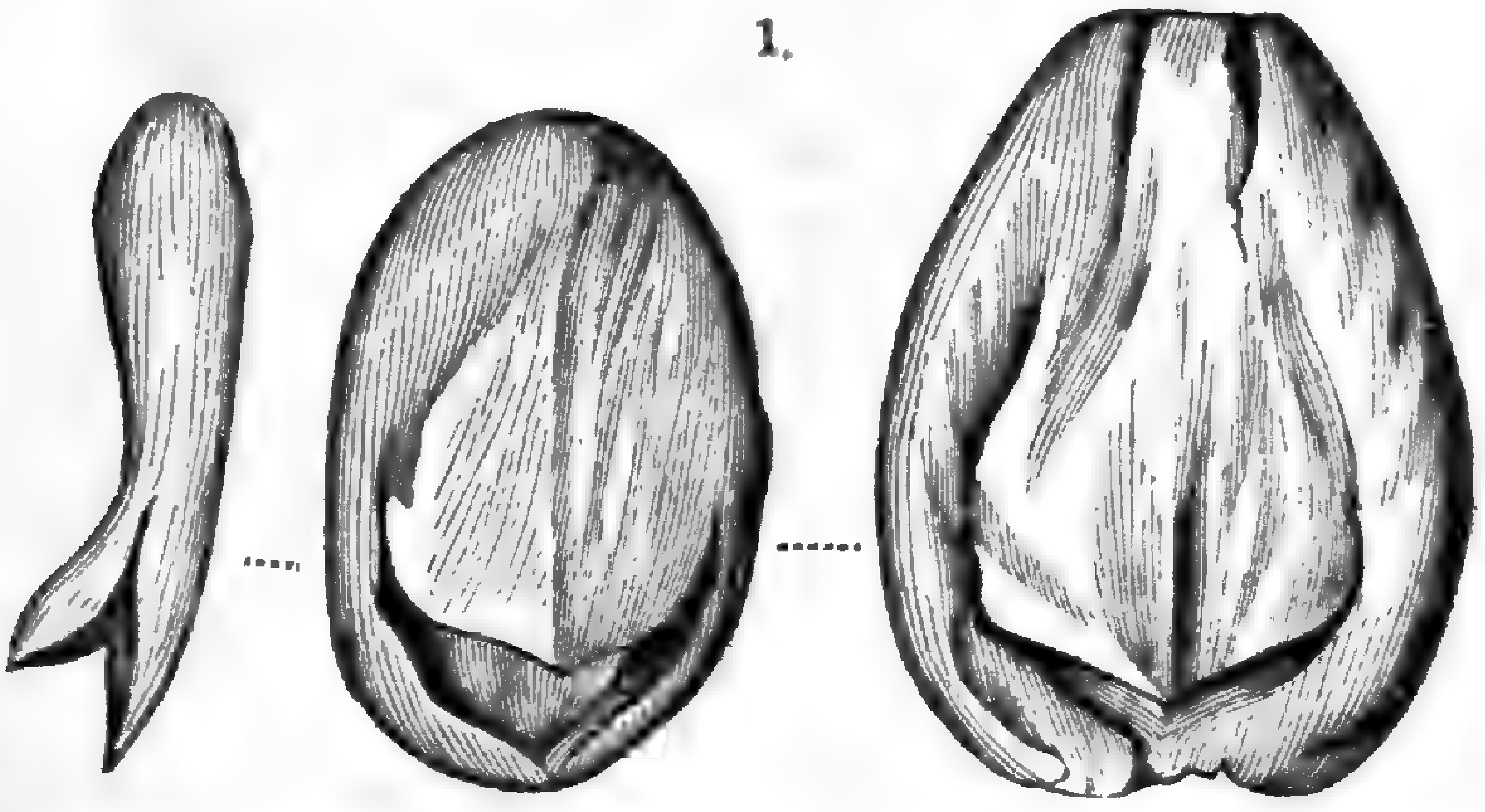


Fig. 1 exhibits the most common fruit, both flatwise and edgewise. It is always thus flattened; and when dried, the two valves exhibit the dehiscence in the figure. These valves are made up of fibrous matter; the fibres lying perpendicular to the surface. The seed is always wanting, but the thin membranous integument once enclosing the seed, often remains. There is considerable diversity in the size and form of these fruits. The figures represent one of middle size and one of maximum size, as well as one placed edgewise. Of this variety I have obtained several hundred specimens.

2.

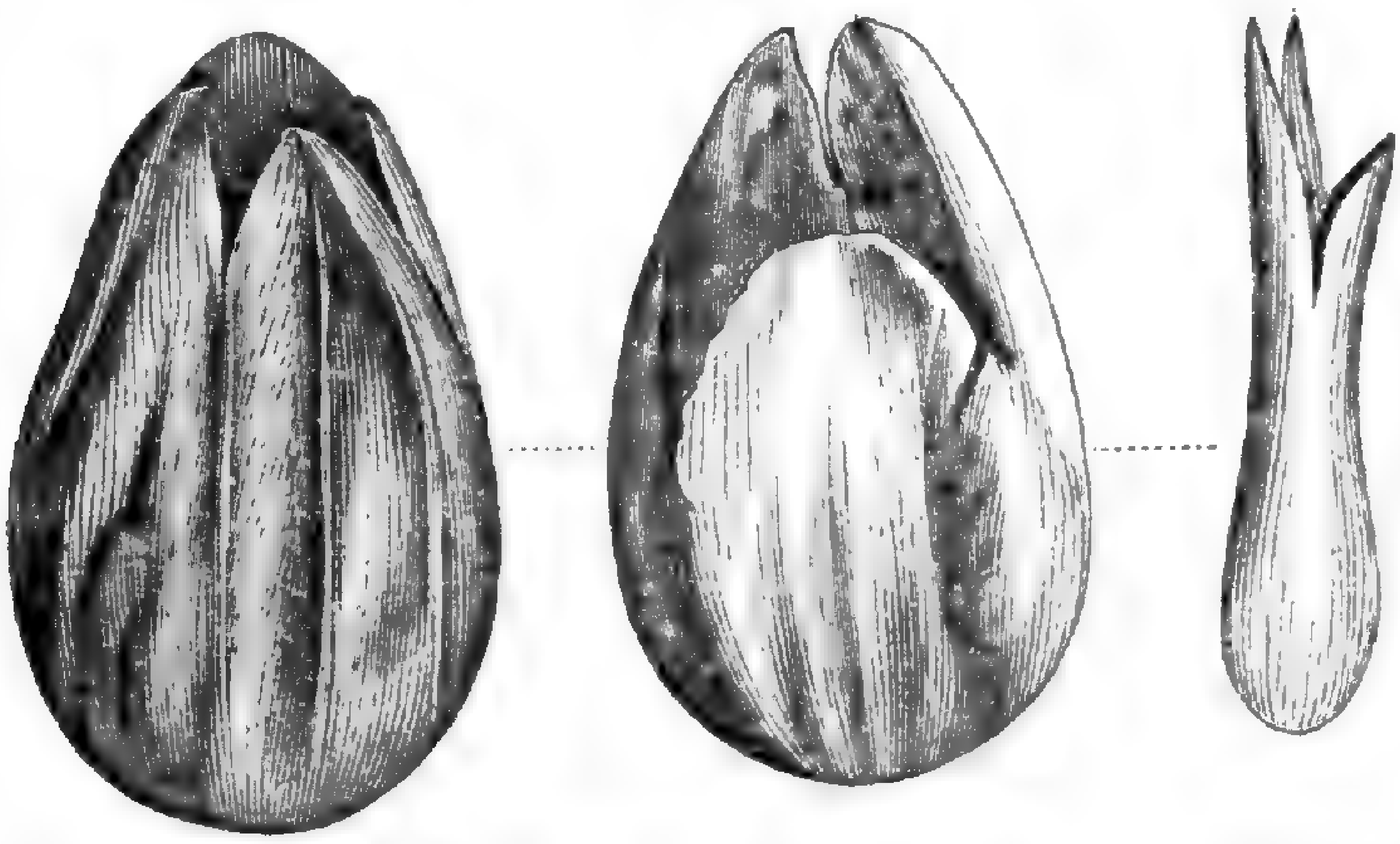
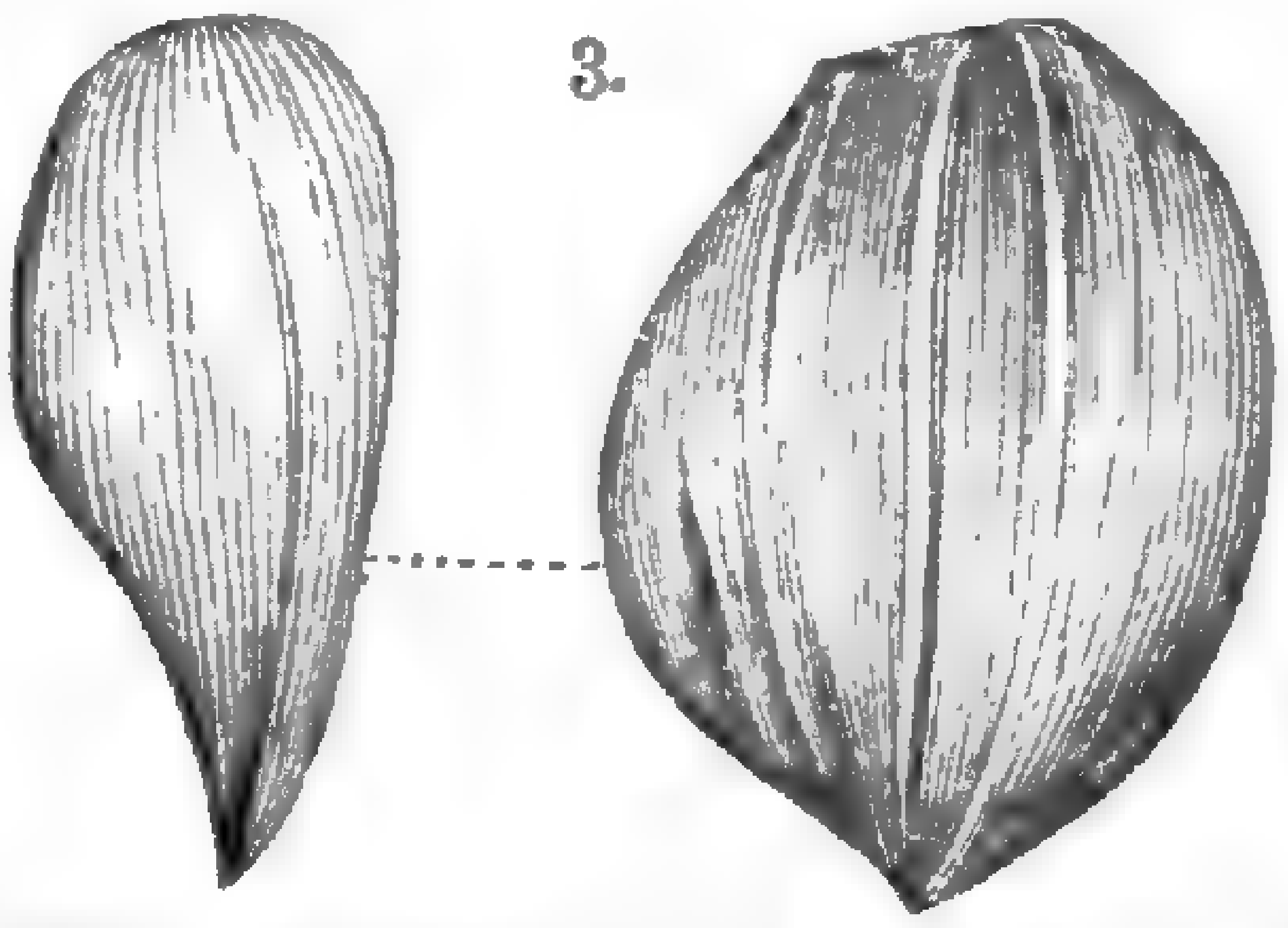


Fig. 2. This is a rare variety of fruit, differing from the last in being more acuminate, in being ridged upon its lower side, and in opening more or less by three valves; yet two of them are more distinct than the other. I have found only two or three specimens; but they are certainly specifically, and most likely generically, different from the last. The figures show both the upper and under side as well as the edge.

3.



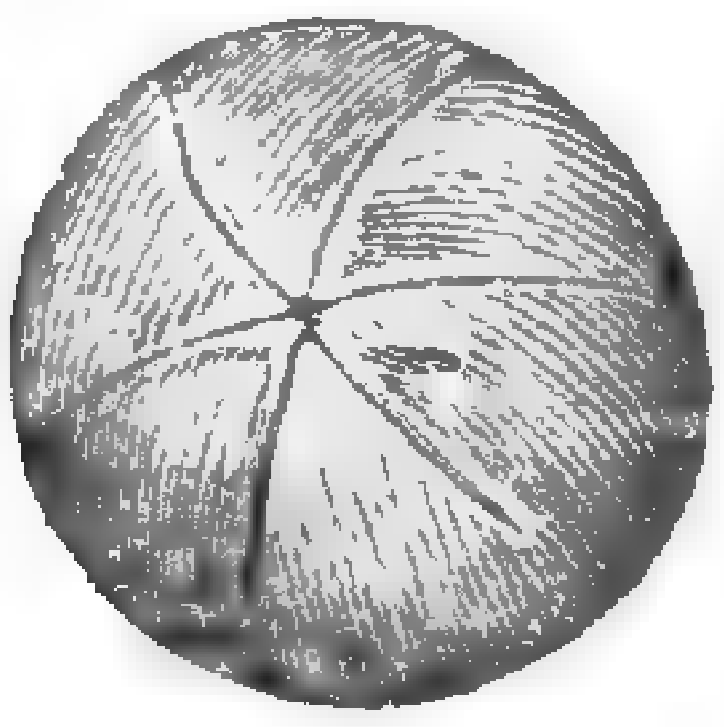
4.

Fig. 3. This species differs from the last in being less acuminate, more distinctly ridged on both sides, much thicker at the upper end, when seen edgewise, and rarely dehiscent. I have found only a few specimens, and those of variable size.

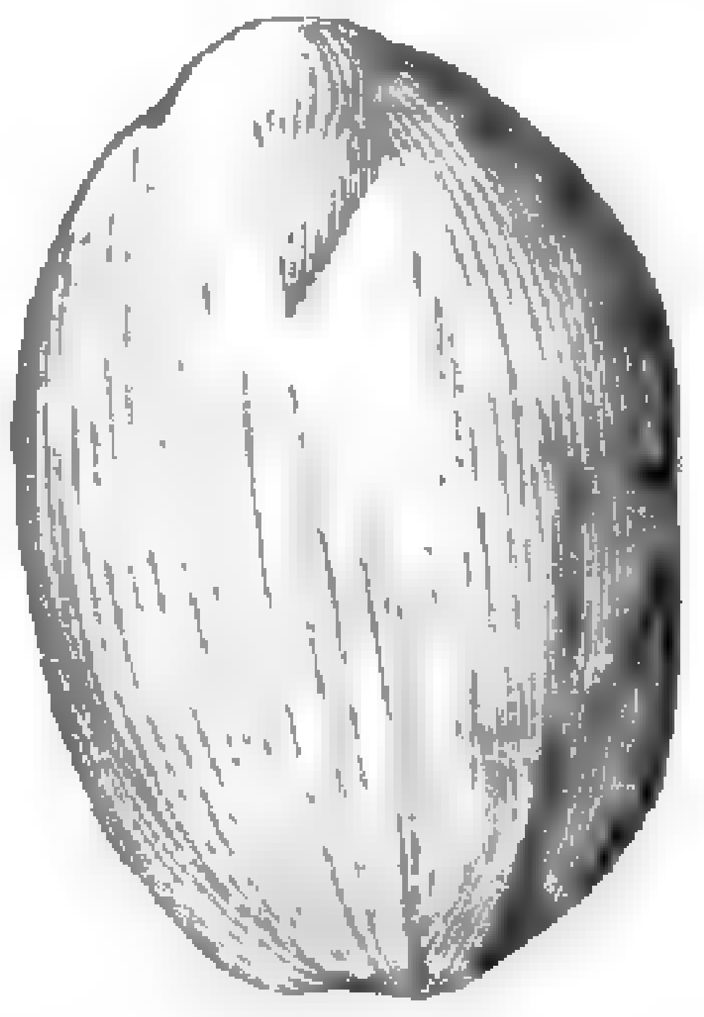
All the preceding pericarps are fibrous perpendicular to the surface, and destitute of a seed.

Fig. 4 represents a not unusual form which was most probably a berry: for on breaking it, it appears nearly homogeneous throughout, and the outer integument is quite thin: yet it shows seven quite distinct meridional lines in distinct relief, sutures as I suppose, though indehiscent. It bears a good deal of resemblance to some species of walnut, but there is no nut within. Its surface is considerably rough and pitted.

5



6.



7.

Fig. 5 differs but little from fig. 4, except that it is smoother, the sutures are less distinct, and form grooves rather than ridges, and the divisions are usually six. It evidently belongs to the same family of plants as fig. 4, and perhaps it is only a variety.

These forms are somewhat common. I think I have found not less than two hundred specimens.

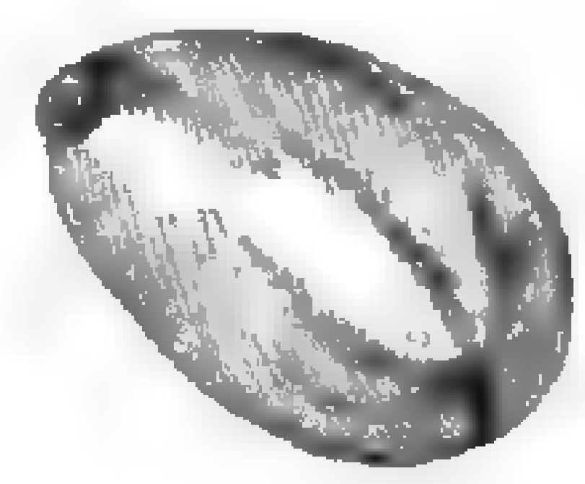
Fig. 6 is in the form of a prolate spheroid, whereas figs. 4 and 5 are almost exact spheres. They all, however, have essentially the same internal character. All have the same thin outer covering, and (with an exception mentioned below) retain the precise form which they had when hanging upon the plant or tree, on which they grew; and the place of attachment for the stem is usually quite obvious, as well as the apex. The internal part of the fruit is usually homogeneous; but I can not discover seeds at all, nor much evidence of cells. The meridional lines on this species are usually six.

Specimens of the last three varieties are sometimes considerably flattened, but in no case have I noticed that the carbonization has diminished the size.

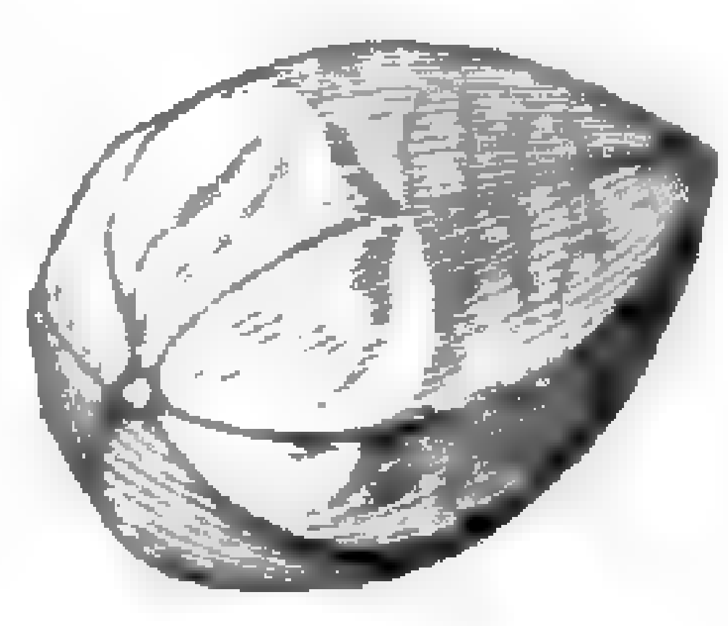
Fig. 7 exhibits a section of a single carpel, which is sometimes developed by breaking open a species of fruit similar externally to fig. 4, except that the sutures are wanting. But in fig. 7 the epicarp is quite thick. The carpel very much resembles that of the Ricinus communis, or castor oil plant.

8.

9.



10.



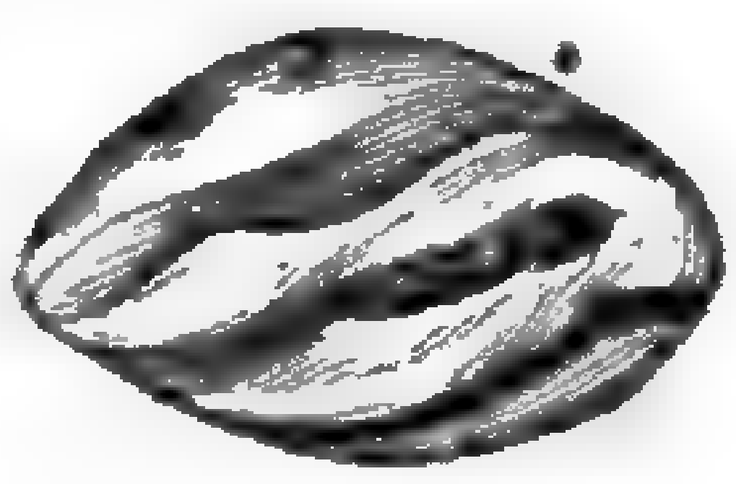
Figs. 8 and 9 were taken from specimens resembling in appearance and internal character figs. 4 and 5, and very probably the fruits from which they are taken are only varieties of figs. 4 and 5, in which the apex is very much aside from the pole of the geometrical axis,—so near the base or stem, in fact, that I am in doubt whether they are not leguminous seeds. But I find examples of almost every intermediate degree of obliquity in this respect.

There is a strong resemblance between these distorted fruits, and those of many species of palms, as figured in Von Martius's great work on that family. And had I been able to detect any monocotyledonous wood among the lignites of this deposit, I should be inclined to refer some of the fruits to that family.

In fig. 10, the longitudinal ridges are more prominent than in those specimens hitherto described, and the fruit is acuminate at its apex. It a good deal resembles certain species of walnut, disengaged from the epicarp. But the fossil fruit has no hard endocarp. It does not in this respect resemble the Juglandites rostrata, of which I have a specimen from the brown coal of Germany.

In fig. 11 the longitudinal ridges are very prominent, and a little oblique to the axis. I think it distinct from the other species that have been described. But as I have found only one or two specimens, I am not very confident.

11.



12.

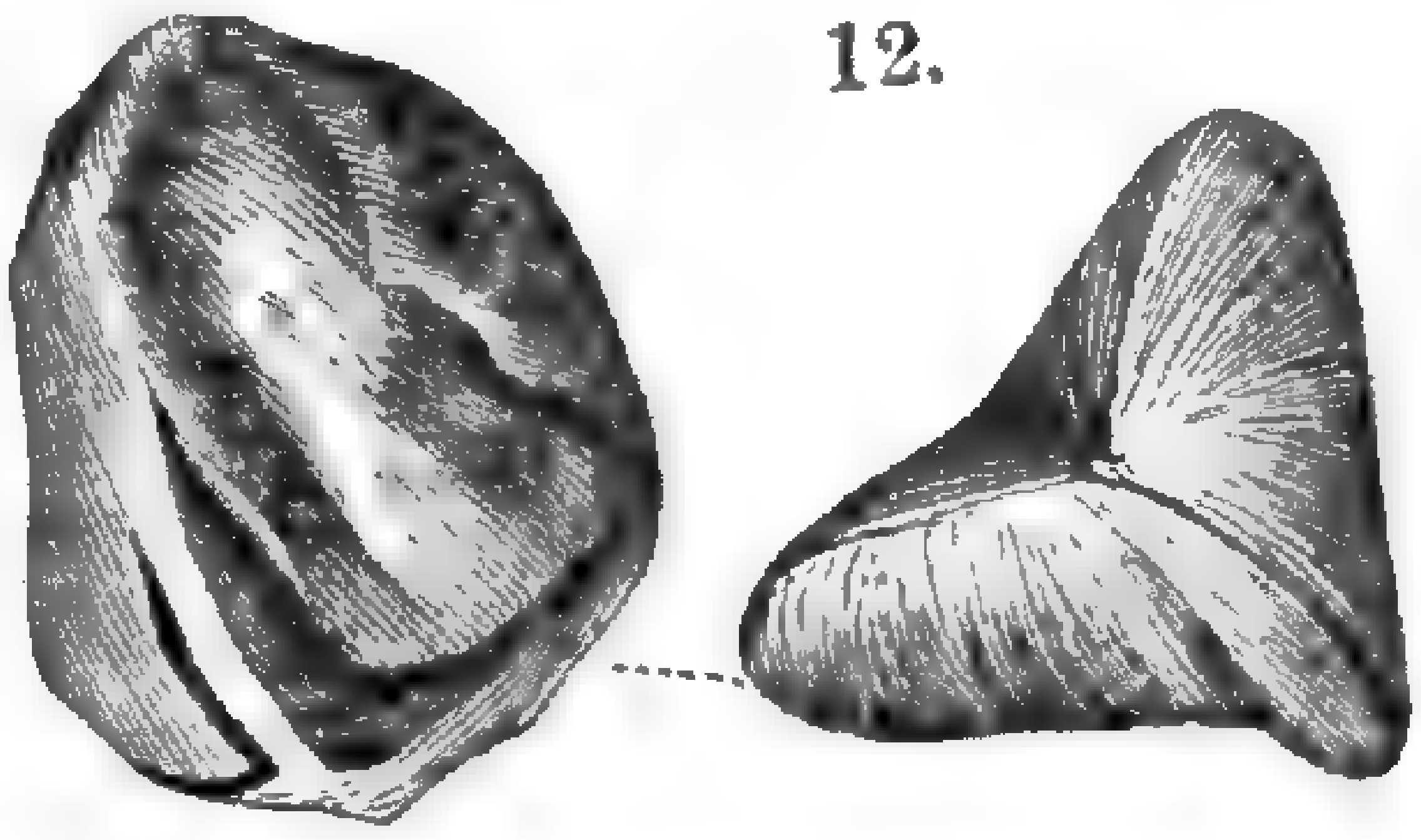
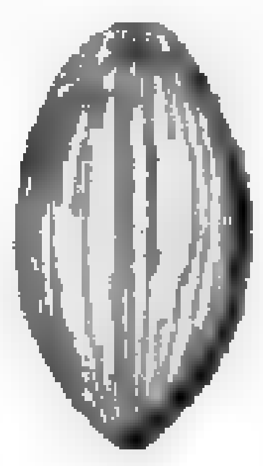
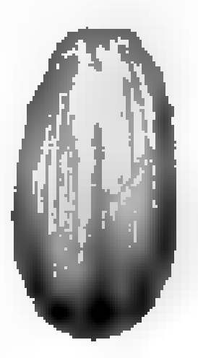


Fig. 12 represents a very distinct species of a triquetrous form. Some of the specimens a good deal resemble the Brazil nut, (*Bertholletia excelsa*,) others have the form rather of a large beech nut, (*Fagus ferruginea.*) Fruit dehiscent at the apex, with two, and probably three valves. Outside rough and somewhat ridged lengthwise. I have but a few specimens, it being one of the rarest species, and have not been able to satisfy myself as to its internal structure.

13.



14.



15.

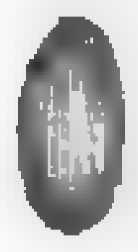
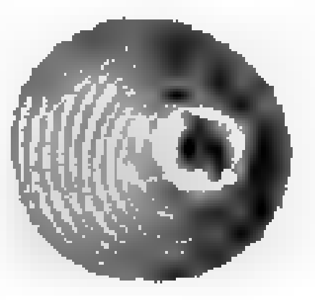


Fig. 13 may be a smaller species of the same genus, as it is somewhat three-sided. But it is more deeply striated, and the largest side, shown in the drawing, is nearly flat. A very rare variety.

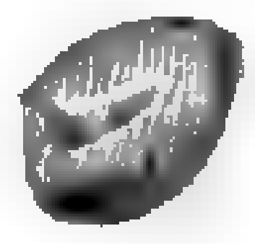
Fig. 14 exhibits an elongated fruit, slightly striated longitudinally, and having an epicarp of considerable thickness. A thin endocarp is contained within; but the seed has disappeared, and frequently, as a consequence, the fruit is compressed, and appears as if two-lobed. This is not an uncommon species. I have perhaps a hundred specimens.

Fig. 15 is probably only a smaller specimen of the last, having a form nearly spherical. It is rare.

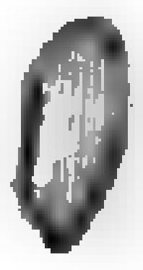
16.



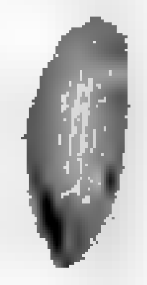
17.



18.



19.



Figs. 16, 17, and 18 are undoubtedly leguminous seeds; though I am not sure in respect to the first, which is somewhat uneven on the outside, and the base, or point of attachment, is a circle. But the other two resemble peas, or small beans, and the hilum is very manifest. They are perfectly smooth on the outside, and as I have found only one or two specimens, I have not examined the inside. I have never seen anything like a pod.

Fig. 19 is an exceedingly beautiful seed, with a hard though thin and frail shell, elegantly striated longitudinally, by waving lines, and corresponding ridges, too fine to be represented on the drawing. This is jet black; but on breaking through it, we find a soft light-colored lining membrane, which evidently once enclosed the kernel. But that has disappeared. The point of attachment is not at either extremity, but near one of them, extending a third of the length of the seed, as shown upon the drawing. It is not an uncommon species, though apt to be overlooked from its minuteness. I have probably obtained thirty specimens.

Fig. 20 shows a piece of the coal, near the right side of which a specimen of fig. 14 is imbedded, and towards the other end, a buff-colored wrinkled integument, (*b*) resembling, save in color, a raisin, and evidently once forming the envelop of a pulpy fruit. It is still quite elastic, and less changed than any of the rest of the fruits. But no signs of what it once contained remain.

20.

The above descriptions, I am aware, are quite meagre and defective. Probably a sagacious botanist, skilled in fossils, would detect more species among my specimens. Some of them resemble a good deal drawings of the fossil fruit and seeds of the London clay, as figured by Mr. Bowerbank, in the first number of his work on that subject. But I have thought it unwise, without seeing his specimens, to institute any comparisons. General considerations make it very probable, that fossil fruits from Vermont, will differ specifically and even generically from those of Europe, even of the same geological period.

The only other fossil fruits that I have known to be found in our country, are a few from the tertiary strata at Richmond, Va. In respect to these, Prof. Jeffries Wyman has kindly furnished me with the following description:

"In my examinations at Richmond I have frequently found lignite, and occasionally fruits; but as I was more anxious for bones, I gave them but little attention. I have identified a species of Carya, (walnut) which was so pronounced by Mr. Teschemacher, Prof. Agassiz, and Dr. Gray. I have also found one species of pine cone, in company with pine lignite. The latter was interesting, as having changed, while lying on my table, from the condition of rotten wood, soft enough to yield to the tip of the finger, into lignite of the usual hardness and having the coal-like fracture. This, however, is no uncommon occurrence, and is said to be well known to geologists. The piece of wood just referred to, had been bored by the Teredo.

"The above are the only instances about which I would speak with any confidence. I have, also, from the same locality, a large mass of fossil resin. The vegetable fossils there found, with the teeth of Phyllodus, Cetacea, reptiles, sharks, &c., show a close resemblance of the Richmond formations to the London clay. I have in preparation a short notice in which the animal fossils of the two are to be compared."

CONCLUSIONS.

Although the specific character of the Brandon fossils are thus imperfectly known, the facts detailed will warrant several inferences of importance in American geology.

I. *The Brandon deposit belongs to a tertiary formation.* The following are the proofs:

1. It lies below the drift, and for the most part, is not consolidated. Its position as to the drift is seen at the openings made near the carbonaceous deposit; and the degree of induration,—or rather in general the want of induration,—corresponds to that of most tertiary deposits.

2. It contains all the important varieties of rock found in tertiary deposits. We have here white and variegated clays—waterworn beds of sand and gravel, beds of carbonaceous matter not bituminous, and deposits of iron and manganese.

II. *The carbonaceous matter in this deposit is strikingly analogous to that of the brown coal formation in Europe.*

1. The lignite has the deep brown color and coal-like fracture of the brown coal deposits that have not been affected by the proximity of igneous rocks, as is the case at Meisner in Hesse. Yet the woody texture usually remains distinct.

2. While this coal is distinguished from peat by burning with a bright flame, it does not give off a bituminous odor, and thus it differs from bituminous coal.

3. The degree of carbonization of the fruits, corresponds to that in the brown coal formation, as a comparison of specimens shows.

4. The sand and clays, associated with the brown coal of the Rhine valley, occur also at Brandon.

III. *The fruits and lignite of this deposit, appear to have been transported by water, and probably the accumulation took place in an ancient estuary.*

1. No example has occurred in which these fruits have been found in clusters, or attached to the branches on which they grew, or to their envelops. Nor have I found more than a single imperfect example of a leaf.

2. The lignite is in broken and usually bruised masses, as if battered by contact with one another when floating down stream.

3. The numerous places in other parts of the United States where an analogous deposit occurs,—as will be shown below,—render it probable that this was formed in an ocean, rather than a lake.

IV. *The Brandon deposit is the type of a tertiary formation hitherto unrecognized as such, extending from Canada to Alabama.*

This formation is identified by the following characters:

1. The most prominent and well known substance in this formation, on account of its economical importance, is brown hematite. In the geological surveys of Vermont, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, and North and South Carolina, this ore is described by Adams, Shepard, Percival, Mather, Henry D. and William B. Rogers, Olmsted, and Tuomey. Throughout this whole distance of 1200 miles, there is a striking resemblance in the character of the ore. It is compact, fibrous, and stalactitical; and much of it is in a state of ochre.

2. It is always more or less enveloped in clay of various colors.

3. It is almost invariably found lying upon, or near, a certain sort of limestone, or its associated and interstratified mica slate. This limestone is usually highly crystalline, and when disintegrated, it shows a large proportion of iron in its composition; and the general opinion of the geologists above named, is, that the iron originated from it. Indeed, Prof. Adams, in his first report on the Vermont Survey, has described a true vein of iron ochre in the limestone, which I have also examined. I have likewise some reason to suppose that Foss's bed of hematite in Dover, N. Y., may once have constituted a bed in mica slate.

In all the northern states, the beds of this ore occur along the western base of high mountains. And from the description of the gentleman above named, I understand this to be the case in the middle and southern states. Prof. Henry D. Rogers imputes this fact to the southern direction of the currents in the great ocean by whose waters the iron and the clay were deposited, and to the greater depression of the valley on its southeastern side. Prof. Rogers is the only geologist, I believe, who speaks decidedly of the deposition of this ore from the ocean. By this supposition he comes so near representing this formation as tertiary, that it would have needed only a bed of carbonaceous matter, such as occurs at Brandon, to have brought him upon that ground. Not improbably, now that the Brandon bed is known, similar ones may be found associated with the ore at other localities: for how long has it remained unnoticed at Brandon!

Thus does the discovery of the Brandon brown coal deposit enable us to add to American geology a tertiary formation nearly 1200 miles long, which may appropriately be placed upon our maps.

V. *This deposit probably belongs to the Pliocene, or Newer Tertiary.*

1. So far as we know, it lies immediately beneath the drift.
2. It is destitute of any consolidated beds, save the nodules of hematite; which is not true of any of our miocene or eocene deposits.
3. The brown coal of continental Europe, to which ours corresponds closely in appearance, belongs to the newer tertiary.

I confess that these arguments are not sufficient to remove all doubts from my mind as to the part of the tertiary group to which this formation should be referred. All geologists, however, I think, will say that it has marked peculiarities, which distinguish it from all the tertiary deposits of our country hitherto described; and we may at least say, that the presumption is strongly in favor of its being pliocene. It is rather remarkable if it was an oceanic deposit, that no marine remains have been found in it. I believe, however, that this is very much the case in Germany; though, unfortunately, the papers of Horner, Von Dechan, and others, on the brown coal are not within my reach.

Art. XVII.—*On a New Kind of Electro-magnet;* by M. Jerome Nicklès.

In the beautiful researches on magnetism of MM. Lenz and Jacobi, these authors have admitted that the magnetism developed in an electro-magnet does not depend on the length of the arms, but that this power is subordinate to the number of turns of the spiral which compose the helix.*

The valuable report published by Professor Muller of Friburg, on the progress of physics, contains some new facts in support of this opinion. M. Muller deduces from his experiments the following conclusions: "Other things being equal, the length of the arms of an electro-magnet is without influence on the weight raised."†

M. Dub has arrived at a different opinion, from recent experiments,‡ which have satisfied him that, under like circumstances, the attraction of an electro-magnet increases with the length of the arms. My own experiments confirm the results obtained by M. Dub, and they are the more satisfactory confirmation, since they were made with a different arrangement and before the later researches of M. Dub were published.

I have pursued for this purpose two different methods, the details of which I will give in a future communication. One is

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* Poggendorff's Annalen, lx, p. 464.

† Berichte über die Fortschritte der Physik, 1850, p. 521.

‡ Poggendorff's Annalen, lxxx, p. 49.

founded on the well known process of oscillation, the other on contact attraction. This latter method I will briefly explain.

I made the experiment more to satisfy my own mind than to verify the influence which the length of the arms of an electro-magnet exercises on the weight sustained: for it always seemed to me that the fact of this influence was evident *a priori;* because by increasing the length of a bar magnet we widen the distance between the opposite poles and diminish the neutralizing effect which these poles exert between themselves.

Yet as the contrary opinion has been sustained by the authorities above cited, I could not give as much weight to this reasoning as I should have done had it been experimentally proved. The fact in question is however put beyond doubt by my researches, and without giving full details, I can demonstrate it by a simple trial, easily repeated even as a common lecture-room experiment. I take a bar of iron surrounded by a helix of copper wire, which I place in the galvanic circuit; I select for an armature a piece of iron whose mass and length, variable according to the current, are such that the armature may be attracted without resting suspended: at this moment I place on the superior pole of the electro-magnet a cylinder of iron and immediately the armature suspends itself to the magnet and adheres there more or less energetically, to fall back when the added cylinder is withdrawn.

This experiment has been varied in many ways and has always given the results above stated. This addition of a cylinder to a bar magnet obviously lengthens it a corresponding quantity, and removes farther off the opposite pole, whose disturbing action is thus weakened.

Suppose a bar sufficiently long provided with a helix at one of its extremities; bend this into the form of a horse-shoe, we have a species of electro-magnet of which one pole only is covered with wire, and which will not less exert a more considreable attractive force when its two poles act at the same time on an armature; and this effect will evidently be obtained without the necessity of augmenting the electric current.

But if, for illustration, we suppose a straight electro-magnet slit in the line of the axis for a sufficient distance, and then if each part of the divided portion be bent back parallel with the other portion, this last, the middle portion, being the pole wound with wire, we have an electro-magnet, (see figures, next page) like a double horse-shoe magnet, with a single pole wound (m), and two outer arms (n) which are naked: and when these two are made to act simultaneously on an armature, a more powerful attraction is observed than if the wire employed had been divided between these arms.

The idea of such an electro-magnet was suggested by the necessity of conveniently protecting the helices against action from without, and my reasoning with reference to it was dictated to some extent by an observation which will be the subject of a future communication. As the experiments are not finished, I will make but a few remarks.

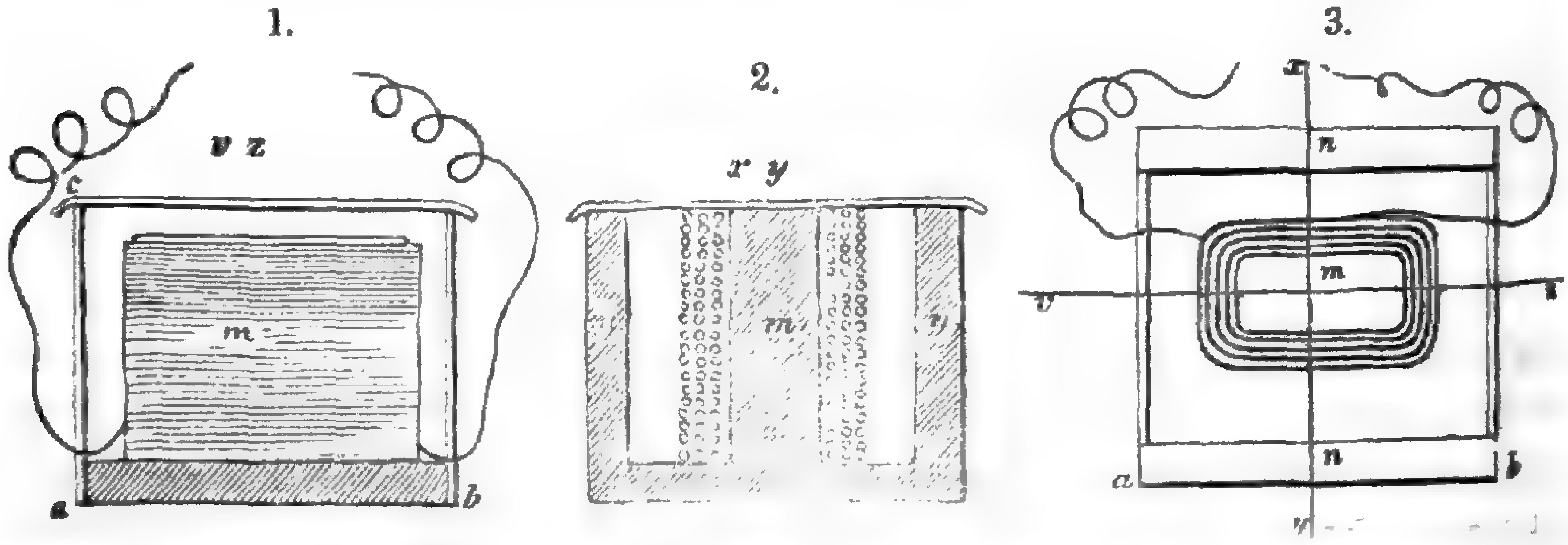

Fig. 1, a section from *v* to *z* (see fig. 3); fig. 2, a section from *x* to *y*; fig. 3, an upper view.

I have for some time tried to increase the adhesion of the motor wheels of locomotive engines by the aid of electro-magnetism, and have made a preliminary trial in connection with M. Amberger, a mechanic. The apparatus used consisted essentially of a helix lodged in a spool of brass and made to surround the motor wheel on the side where it touched the rail; the wheel could turn in the helix freely and without touching it. We found that when a strong current was passed, we could give the wheel at the point of contact sufficient magnetism to increase its adhesion.

A trial on a large scale has been made by me on the railroad from Paris to Lyons with a locomotive of 28 tons weight, drawing a train of about 100 tons, on a grade of ten millimetres inclination. An official report given to the minister of the public works, states that in this first trial we obtained through the magnetism about nine per cent. of additional adhesion. The attraction in a state of rest was 650 kilogrammes per wheel, or 1300 kilogrammes for a pair of wheels.

It is apparent, that when such a force is concentrated on a tangential point, the magnetized surface must be of considerable extent. In fact, the magnetic radiation was very perceptible at a distance of more than eight metres, and at two metres the apparatus would easily cause two bars of iron weighing 500 grammes to adhere.

This radiation, which proceeds partly from the magnet and partly from the helix, embarasses the results, producing especially a loss of force, and I have sought to get rid of it. I will say on another occasion how this difficulty is removed for the special case of wheels; I here only state that I have in the presence of this radiation conducted the experiments before mentioned; and that I have conceived the idea of taking three plates of iron united perpendicularly to a fourth plate, and of placing the wire only on the central arm, in the manner explained.

The following are the dimensions of this electro-magnet, (see figures.)

		Millimetres.		Inches.
Height *a* to *c*	=	0·08	=	3·144
Length *a* to *b*	=	0·10	=	3·937
Thickness of *n*	=	0·011	=	0·432
" " *m*	=	0·023	=	·903
Length " *m*	=	0·067	=	2·633
" " *n*	=	0·098	=	3·851

It is clear that by putting plates of iron on the two free sides and fixing over the polar surface a plate of steel so as to inclose the whole, the copper wire would be as completely protected as possible against every species of accident. The electro-magnet may be exposed to all kinds of danger without fear of injury, and in this state may be used as a brake on railroads to stop the speed or motion of the cars.

When the poles of this magnet are examined separately, it is found that the central pole only has attractive force, the two other arms having but little power; moreover, their polarity is evidently the opposite of that of the central pole; but on placing an armature over the latter, we observe at once that the two outer arms have become very powerful, conformably to the fact stated before with reference to straight electro-magnets. It is the same, if in place of putting the armature on the central pole, it be put on one of the outer arms, and, as I have remarked, it is thus with all electro-magnets, straight, curved or circular. In general, increasing the strength of one pole, is adding to the strength of the other, and the reverse.

ART. XVIII.—*On the Permeability of Metals to Mercury;* by M. J. NICKLÈS.*

IN an interesting memoir on the permeability of metals to mercury, by Prof. Horsford, this author establishes the fact of the permeability of tin, lead, gold, silver, zinc, and cadmium, and contests that of copper and brass.

The negative results which this chemist has obtained with copper and brass, have evidently proceeded from the process which he has followed; for, some time since while engaged in my researches on magnetization, I observed positive facts to the contrary. I was using at this time a Bunsen's battery, with zinc exterior. The connecting pieces of copper were riveted to the zinc; and on amalgamating the latter metal, it often happened that the mercury spread itself over the copper in contact with the zinc: and after a certain time, the metal

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* Communicated by the author in French for this Journal.

of the connecting pieces became brittle, and had on breaking, a white color. It was obviously no longer copper, but an amalgam of this metal.

This fact had too important a bearing on the amalgamation of zinc, which occupied me at that time, to be allowed to pass without examination. The experiments which I made on this subject, led to the general conclusion, that the metals which absorb mercury are permeable by it, and communicate this property to the alloys which contain a certain proportion of permeable metal. The metals on which I have operated are zinc, iron, cadmium, tin, copper, lead, antimony, silver, gold, and platinum. The manner of experimenting was suggested by the fact which had led to the researches. With a stylet I traced a line or furrow on the plate under experiment, and placed a little mercury in this furrow. In order to hasten the amalgamation, I introduced, before the mercury, a drop of bichlorid of mercury, acidified with hydrochloric acid. By this means, the amalgamation takes place instantly, and the surface is fitted to retain at once the quantity of mercury necessary for the effect I would produce.

A plate of zinc, a millimeter thick, is immediately attacked, and at the end of a minute, it is cut in two in the direction of the furrow. A thicker plate requires more time, and a deeper scratch on its surface; with a thickness of six millimeters, the plate took ten minutes and a little effort to break it: but in all cases the fracture was neat, and in the direction of the scratch or furrow.

After zinc comes cadmium and tin, then lead, silver, gold, and finally copper. All of these metals become amalgamated: the mercury infiltrates after a time more or less long, and renders them brittle. No permeability has been detected in iron, antimony and platinum, and these metals make no amalgam. Daniell has found a bar of platinum free from mercury, that had been for six years in contact with it; and to this time no amalgam of iron has been reported.

There exists, it is true, an amalgam of antimony, but, according to Wallerius, when this amalgam, of a pasty consistence, is triturated in the air, or when agitated with water, it loses its antimony in the form of a black powder.*

As to the action of mercury on metals, this fact at least is established:—the resistance of some to amalgamation, and the easy amalgamation of others. We have also shown that the permeability takes the same direction; and we may conclude therefore that the alloys will participate in these qualities in the order of their composition. In fact, a plate of bronze, five millimeters

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* I should recall, in this connection, that mercury also is reduced to a black powder by agitation in the air.

thick, may be cut in two by mercury, after ten minutes of contact, and a plate half a millimeter thick, yields instantaneously. On amalgamating a strip of brass, it may, after a few minutes, be reduced to fragments between the thumb and finger. A plate of four millimeters required ten minutes to cut it in two. An alloy, formed of equal parts of antimony and tin, did not appear to be impressed by the mercury. Chaudet's alloy (3 or 4 per cent. of antimony, and 96 to 97 of tin) very elastic in its pure state, amalgamates instantly, and is easily cut off.

It is here seen that if the permeability of brass and copper for mercury is not established by the process, based on *capillarity*, followed by Prof. Horsford, we may still make this property evident by an inverse course, that is, by inducing *infiltration*.

As these experiments were made only incidentally, and were not intended to be published, I have not attempted to give them precision. Nevertheless, the facts which have been mentioned above are well established; for I have been accustomed to use this process for dividing plates of zinc or sheets of brass, in my experiments on electro-magnetism.

SCIENTIFIC INTELLIGENCE.

I. Correspondence.

Correspondence of M. J. Nicklès, dated Paris, September, 1852.

There was but little done at the Academy of Sciences during the month of August. Vacancies occurred; and the academic chairs vacated were filled by the election of several illustrious foreigners, among whom are MM. Mitscherlich, Gustaf and Heinrich Rose, and Plücker.

There have been read before the Society, this month, two memoirs on General Physics,—one of them on molecular physics, the other on the relation of specific heat to atoms.

Researches in Molecular Physics.—The principal fact of interest in the first, is a new case of isomerism, which its author, M. Pasteur, has discovered, and which facts previously known could not have suggested. This able chemist of Strasburg, arrived at this result when pursuing his researches on the relations which exist between crystalline form, chemical composition, and rotatory molecular phenomena, and has thus thrown new light on the mechanical department of chemical combinations.

M. Pasteur had previously established the principle that the direction of the rotatory molecular action of solutions depended on the hemihedrism of the crystals, that rotation to the right implied a right-handed hemihedrism, and to the left, left-handed. Further, that one and the same substance may furnish examples of both of these characters, or in other words, that two substances, one right- and the other left-handed, may differ only in crystallographic and rotatory peculiarities, being in every other respect identical.

His first researches had been made on crystals of tartaric and racemic acids. Each of these acids presents both kinds of hemihedrism, under the same crystallographic planes, one being the reverse of the other. But the two acids, the right- and the left-handed, afforded by racemic acid retain their peculiar hemihedral and rotatory properties in their compounds when the bases present are without action on polarized light; the two series of salts are identical except in the hemihedrism and the rotatory phenomena.

But he has now made the new discovery, that if, in place of combining these acids with bases inactive to polarized light, they are united with substances that affect the plane of polarization in some way, all identity ceases. The corresponding compounds have no longer the same composition, nor the same solubility; neither do they act in the same way when exposed to a high heat. Often the combination is possible with a right-handed substance, and impossible with the left-handed. Thus the right-handed bitartrate of ammonia combines equivalent to equivalent with the ordinary bimalate of ammonia, which is active in polarization; but the left-handed bitartrate enters into no combination with this bimalate.

M. Pasteur cites a large number of examples of this kind, and explains in a simple manner these important phenomena. When the two tartaric acids, the right and the left, combine each with an optically inactive substance, such as potassa, the inactive substance modifies in the same manner the rotatory power of both compounds. The two acids were identical though not superposable optically, and this is still true of the two compounds. But when the two acids are united to an active base, as cinchonine, there is in one case an *addition* to the rotatory power, and in the other a *subtraction*.

M. Pasteur considers it probable that all right-handed substances may have a corresponding left-handed condition, and reciprocally. He also believes that every active substance may have an inactive correspondent. He further announces that he can easily communicate the rotatory power to a large number of organic products, and that he has succeeded in transforming cinchonine and quinine into new isomerous bases which are inactive to polarized light.

On the relation of Specific Heat to Atoms.—The law of Dulong and Petit has been extended through the researches of M. Garnier, who has determined the relation that exists between the specific heat of water and that of a simple body on one hand, and between the atomic weight of water and that of the same body, on the other.

If we divide the atomic weight of water 112·5 ($H^2=12{\cdot}5$ and $O=100$) by 3, the number of the elementary atoms, we have $112{\cdot}5 \div 3 = 37{\cdot}5$, a number which may be called the elementary atomic weight of water. On comparing this mean atomic weight with the atomic weight of simple bodies, we find a curious relation between this weight and the specific heats. Thus the atomic weight of copper is 395, consequently, (as $395 \div 37{\cdot}5 = 10{\cdot}5$,) this number is 10·5 times greater than the mean atomic weight of water. The specific heat of copper is 0·0951, that of water being 1, and hence dividing the latter by the former ($1{\cdot}0000 \div 0{\cdot}0951 = 10{\cdot}5$), we ascertain that the specific heat of water is 10·5 times greater than that of copper, or precisely in an inverse ratio to its mean atomic weight.

If, as is not improbable, the same relation subsists between water and other simple bodies, we may calculate directly the specific heats of the simple bodies from the atomic weights. It is only necessary to divide the mean atomic weight of water, 37·5, by the atomic weight of the simple body and reduce the fraction obtained to decimals.

M. Garnier has presented his results in tables. He feels assured, that what in this relation is true of water is equally true of other compound bodies.

These results call to mind a relation brought out by M. Hankel,* between the crystalline form of metallic iron (tesseral system) and oxyd of antimony (tesseral) on one side, and peroxyd of iron (rhombohedral) and metallic antimony (rhombohedral) on the other—an alternate relation like the preceding, having a resemblance to the above in this respect, and which on no other ground has admitted of generalization.

Double Refraction artificially produced in Crystals of the tesseral or regular system.—A memoir on this subject by M. Wertheim, has afforded a generalization of a fact observed long since by Biot, namely, that substances not possessing double refraction may acquire it from pressure.

This author, engaged in the vaults of the Conservatory of Arts and Measures, continues with perseverance his researches on the modifications which matter may undergo under the influence of torsion, traction and compression. I have seen at his rooms, plates of fusible, untempered steel, twisted in every direction, which retained perfectly the form which the torsion had given it, contrary to the opinion of some authors (Lagerhjelm and others) with regard to the elasticity of this metal.

Lightning.—Communications to the Academy on cases of lightning are quite frequent, owing especially to the impulse given to the study of these phenomena by M. Arago. The observations made during the storms of the present summer (1852), have placed beyond doubt the important fact respecting "globular lightning," that it differs from ordinary lightning in several points, especially in the slowness of its movement, less brilliancy, and also by its apparent indifference to metallic conductors, which ordinary lightning follows with great readiness. This kind of lightning, first distinguished by M. Arago, from facts on record, comprises a variety of meteoric phenomena known under the name of thunder balls, thunder globes of fire, globular lightning, fulminating globes, ("Tonnerre en boule," "tonnerre en globe de feu," "foudre globulaire," "globe fulminant,") and according to Babinet, it often accompanies strokes of ordinary lightning.

It is desirable that the kind of *lightning conductor* suggested by M. Arago, should be constructed, which discharges clouds of circumscribed thunder storms by means of anchored balloons, and so prevents the disastrous effects of these storms, as has already been done by M. de Romas, Dr. Lining of Charleston, and Mr. Charles, with kites provided with conducting cords. Since according to Franklin's observations, lightning rods are more effective the greater their height, we may by means of balloons obtain currents of electricity which possibly may be

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* Poggendorff's Annalen.

of use in agriculture and industrial operations. Who does not remember the long sheets of light which Franklin and M. de Romas succeeded in drawing close beside them from their kites. Since electricity is effective in ozonizing oxygen and converting it into *electrized* oxygen, (as it is designated by MM. Becquerel and Frémy,) so increasing the action of its affinities, we may believe that the fertilizing influence of the rain of storms may be due to the oxygen of the atmosphere they electrize, rather than to the nitric acid, or the nitrate of ammonia found in the waters. Without denying the influence of these azotized substances, we know that ozone is produced on such occasions in torrents, and plays a principal part.

I will give in another place, a description of the apparatus used by MM. Becquerel and Frémy, in their experiments on electrized oxygen, and which with a single element of Bunsen's battery afforded in a vacuum a continuous spark several centimetres in length.

Butyric Alcohol.—Among the chemical facts brought forward at the Academy the past month, we notice the discovery of butyric alcohol by M. Adolph Wurtz. This alcohol, $(C_8H_9)O, HO$, which has been detected by M. Wurtz in the caput mortuum of the oil of potatoes, so much studied by chemists, furnishes a new verification of the beautiful theory of alcohols of Dumas, in which several lacunes have been recently filled by the cerotine and melissine of Mr. Brodie, and by the caprylic alcohol which M. Bouis has derived from castor oil.

Researches in Analysis.—Two memoirs bearing on the subject of analysis, of very opposite character, have been presented to the Academy. One by H. Sainte Claire Deville, "on new general processes in chemical analysis," complicates this branch of science with a series of precautions and processes quite appalling to the practical man or the amateur chemist. M. Deville uses only reagents that are volatile, in such a way that the proof of their purity, under certain relations, can be obtained exclusively with a plate of platinum. The memoir does not say how to determine sulphuric acid, phosphoric acid and numerous other bodies. And while waiting for the author to explain himself on these points, we may believe that the present condition of analytical chemistry is not so bad that the method of Deville has much to change in its processes.

The other memoir is by MM. Fordos and Gélis. Its object is to simplify, and that very much, so as to render accessible to those little experienced, a determination which has been undertaken hitherto only by professional chemists. We refer especially to the analysis of cyanid of potassium, so much used at the present time in the galvanoplastic art and in photography, and which is always impure and of variable composition, rarely containing more than 50 p. c. of the real cyanid.

MM. Fordos and Gélis—well known for their fine memoirs on the acids of sulphur, and who besides have produced the double hyposulphite of gold and soda, so important in photography—have applied to the examination of the cyanid of potassium the process which had succeeded with them so well in the analysis of the sulphur acids, and which consists in using a normal liquid of iodine. The reaction is very simple, as follows:

$$CyK + 2I = IK + ICy.$$

The memoir gives the details of manipulation, and provides for the adulterations to which the cyanid of potassium is liable.

Besides the researches which have been presented to the Academy of Sciences, which will soon be known in America, if not already, there are others either unpublished or little known, which merit at least a mention of their titles to engage for them the attention of the scientific public.

Of this number, one is the apparatus of Ruhmkorff, already mentioned, by means of which, *dynamical electricity is transformed into static electricity.* Another is,

A new Process for determining Dilatations, by M. J. F. SILBERMANN, the director, as learned as he is modest, of the National Conservatory of Arts and Measures. This process was employed for the first time in the comparison of the standard meter which formed a part of the collection of weights and measures sent to the United States by the French Republic in exchange for the collection of weights and measures from the government of the United States.

The processes hitherto used give the dilatations only to a sixteenth of a millimeter, which degree of precision had been considered very satisfactory. But M. Silbermann has exceeded this limit, carrying the precision even to the one-hundredth of a millimeter. The feature in this process consists essentially in employing a new method for tracing an invariable length on the rules used in investigating the dilatation between 0° and 100° C. To arrive at this invariable length, M. Silbermann uses a beam compass with very solid points held in a wooden trough full of melting ice. This compass is made of a steel rule $1^{m}\cdot20$ long, 5 centimeters wide and about 8 millimeters thick: it carries two very solid points, attached at a distance of a meter apart. The points are of tempered steel and their extremities are turned and sharpened with great care. The trough for receiving the compass is triangular, "l'une de ses arètes tournée vers le bas;" and there are two openings through which the points of the compass pass.

Whilst the compass is in the melting ice, the rule which is under trial is also put in, and this last is kept in for at least two hours. After this time has elapsed, the beam compass is placed on the rule, and after the pointing is done, the latter is taken from the melting ice. The rule is then put in boiling water for two hours, preparatory for the second pointing. The difference of dilatation is then determined by means of a simple combination of lenses, the arrangement of which cannot be well explained without figures.

M. Silbermann has had the kindness to go through this process in my presence; and it will give some idea of its simplicity when I say, that I afterwards repeated the process with little trouble and very satisfactory results.

This same process has also been used to determine the co-efficient of dilatation for a meter of platinum, sent by the French government to the Great Exhibition at London.

The absolute dilatation of the meter of annealed steel, sent to the United States was found to be 1·0502 millimeters, between the temperatures of 0° and 100° C. Compared with the standard of platinum, deposited at the Conservatory of Arts and Measures, the annealed steel meter was found to be 0·0266 millimeters too short, so that the legal value of this standard meter is 0·9999774 meters, whilst the brass meter, also sent to the United States, has the value 1·0002992 meter at 0°. Its coëfficient of dilatation was determined by Gambey. In another communication we will give a figure of Silbermann's apparatus.

Ruhmkorff's Apparatus for transforming Dynamical into Statical Electricity.—The construction of the apparatus is based on the fact demonstrated in 1841, by MM. Masson and Breguet, that the fluid developed by induction in a helix surrounded by another traversed by a galvanic current, by turns interrupted and re-established, is statical electricity. The principle is thus applied by Ruhmkorff.*

S, is a helix formed of 8000 spiral turns of a copper wire one-third of a millimeter in diameter. This helix contains within it another formed of 300 turns of coarser copper wire, two millimeters in diameter, whose extremities end in the two small columns A A; the extremities of the wire of the other helix pass through a clamp in the columns B B. The wires of the two helices are perfectly insulated, and the outer borders, C C, of the latter, terminate in two plates of glass secured by the pieces D D. At the centre of the two helices, a cylindrical bundle of iron wire is placed, in order to augment the intensity of the current of induction by the magnetization which it undergoes while the current is passing.

The pile used with this apparatus communicates with the clamps E E through conductors; from E the current passes to the break-piece F, which takes it to the coarse-wire helix (the inner); the direction in which the current is to pass is regulated by means of the button M, which is fastened at the axis of the commutator or break-piece. The interruption of the principal current is made by means of a mechanical arrangement like that which we describe below, which was first proposed by De la Rive and afterwards improved by M. Miraud. In the apparatus of M. Ruhmkorff, this kind of break-piece consists of a hammer, fixed to a shank which rests on the support O, and which can turn on a hinge so that it may rise and fall. The superior surface of its extremity is terminated by a piece of soft iron covered with a thin plate of platinum; against the bundle of iron wire above this same extremity and opposite to it, there is another surface covered also with platinum which acts as an anvil. When the core of iron wire is magnetized by the passage of the current, it draws the hammer to it; but as the hammer on rising breaks the circuit, the principal current ceases, the core loses its magnetism, the hammer no longer attracted falls by its weight; then the current being re-established, the hammer is again raised, and so on. By these alternations, rapidly made, a current of induction is produced in the helix with fine wire (the outer). To facilitate the magnetization and demagnetization of the hammer and regulate the number of interruptions, a plate of soft iron, P, is placed on a small table in front of the core of iron wire and below one of the columns A, which may be moved up or off at will.

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* We retain the particulars of the description as written out by M. Nicklès; but owing to indistinctness in some parts of the drawing, we are compelled to omit the figure.

To experiment with this elegant little machine, the conductors for receiving the electricity developed are fastened in the clamps B B; if these conductors communicate with the outer and inner surfaces of a Leyden jar, they charge it as well as if the jar were put in connection with an ordinary electrical machine. If we connect with this apparatus the two balls of an electric egg, a series of sparks is produced, forming a true flame, passing from the negative to the positive pole, which demonstrates once more the curious fact discovered by M. Neef, that electric light appears always at the negative pole of the pile. The fact is much more marked when a vacuum is made; as the air leaves the egg, the light becomes more distinct, and when the vacuum approaches its maximum, there is a true luminous arc more than a decimeter in length.

M. Sinsteden, who has paid much attention to subjects of this kind, has arrived at similar results. It was he who suggested the most important peculiarity of this apparatus,* which is, the complete isolation of the two helices, a result accomplished by enveloping each in two tubes formed of leaves of tin, separated from one another by silk and shell-lac. These tubes become thus true condensors, giving electricity of tension, as if in communication with an electrical machine. As to the rest, Mr. Henry and M. Riess have a long time since made observations of a similar character.†

This machine may also give shocks. By fastening in the clamps B B, the extremities of the conductors which end in the handles, and taking hold of the handles with the hands, there is a shock which may be made insupportable. A burning sensation is felt on touching one of the clamps with the finger.

In connection with the facts which have been stated, it is important to mention a singular observation made by M. Ruhmkorff, which he reported to me more than a year since, and which M. Sinsteden has also since brought out.‡ It has been seen that the hammer and anvil are covered with platinum foil. But if silver-leaf be substituted, no sensible sign of static electricity is observed, and hardly any sensation is felt on touching the conductors with the tongue. M. Sinsteden attributes this singular effect to the greater conductility of silver and consequently its less resistance. This does not appear to us admissible, for M. Ruhmkorff has observed that copper, which is nearly as good a conductor as silver, affords nearly the same effects as platinum.

The following is a brief description of

De la Rive's Interruptor as improved by Miraud.—An electro-magnet A, (fig. 2) is placed horizontally or vertically on a flat surface, and is put in connection on one side with one of the poles of a galvanic pile, and on the other with a flexible spring, G H, which carries at C a plate of soft iron. This spring rests against another spring

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* Poggendorff's Annalen, lxxxv, 492.

† [The name of Dr. C. G. Page should here be added. There are many points of similarity between the apparatus of M. Ruhmkorff and the compound electro-magnet and electrotome of Dr. Page, whose apparatus appears to be but little known in Europe. See this Journal, vol. xxxv, 252, 1839.—Eds.]

‡ Poggendorff's Annalen, May, 1852, 482.

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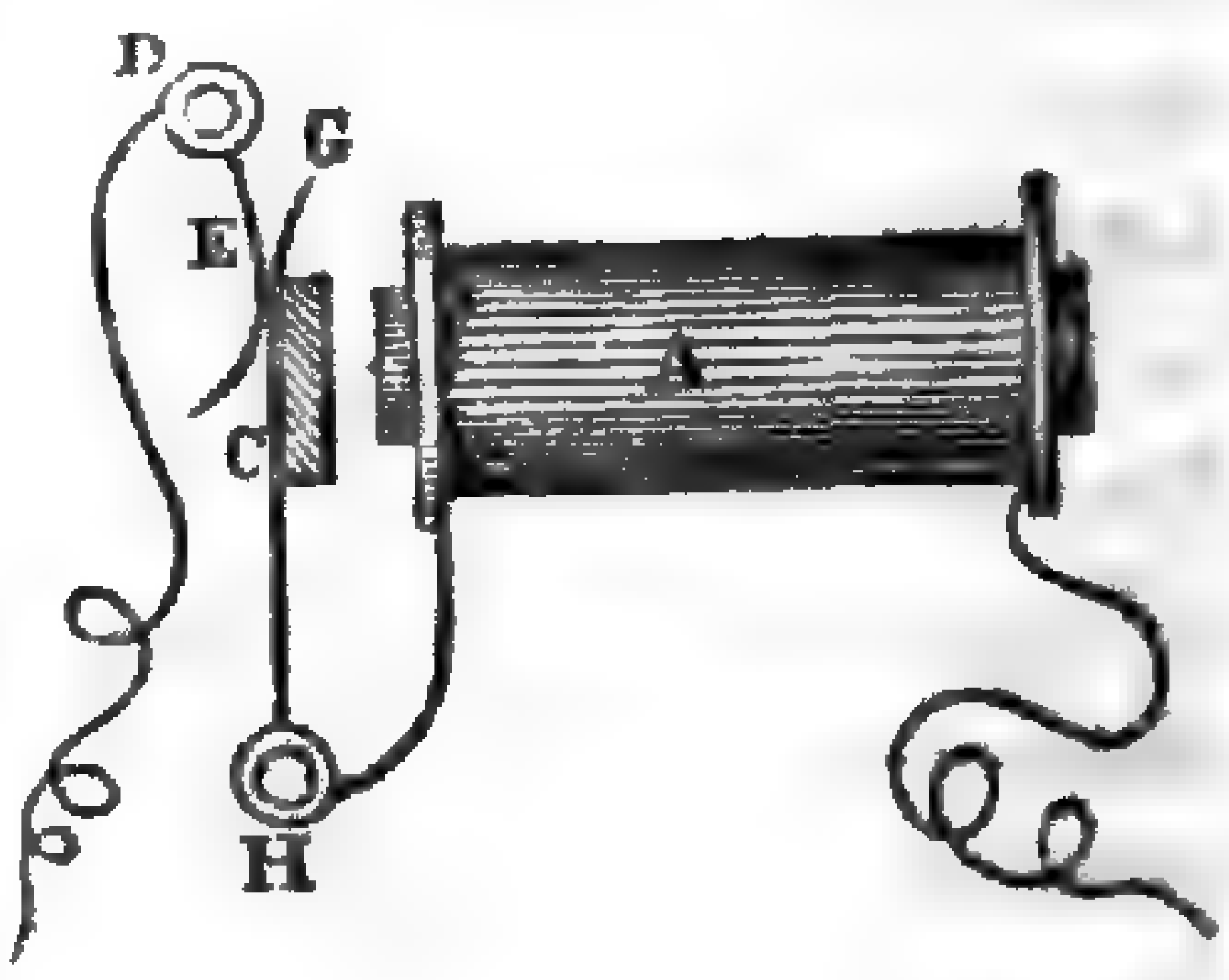

D E, which is put in communication with the other pole of the pile. When the spring C H touches the spring D E, the current is closed and the plate C is attracted at once by the electro-magnet: this interrupts the current and the spring C H springs back to the spring D E; when the current passes anew and there is another attraction, and so on. The vibrations produced by this arrangement are so rapid that it produces a sound like the buzzing of a fly.* This apparatus has been applied to electro-medical purposes, in which it is a convenient substitute for toothed wheels.

Correspondence of T. S. Hunt of Montreal, on Atomic Volume.

As to atomic volume I have a new suggestion. In the gaseous state, volumes and equivalents are identical, and an idea of this kind, as true to a certain extent of bodies in the solid form, lies at the basis of the calculations of Kopp and yourself; but while in some cases the volume appears identical, in others it varies widely. Now in vapors we should, from a want of such conformity, have argued that the equivalent was not rightly fixed, and this you know is readily determined otherwise in most organic volatile bodies; while in minerals we have arbitrarily assumed the simplest ratio of the constituents, as expressing the equivalent, and shaped our atomic volume to this. Now I suppose that all bodies in the same crystalline form have the same atomic volume, and hence from this we may calculate their true equivalents; hence their relative equivalent being the same, the density is the index of their complexity, or in other words indicates, (pardon the truism,) their degree of condensation. To begin by fixing an equivalent,—*Alum* (in the regular system,) is $\dddot{\bar{\text{A}}}\text{l}\,\dddot{\text{S}}_3.\dot{\text{K}}\,\dddot{\text{S}}, 24\dot{\text{H}}$ and with an equivalent of 474·6 ($\text{H}=1$) and sp. gr. 1·75 has a volume of 271. Chrome alum is 268·6. The mean is about 270. Compared with this, *magnetite* is not ($\text{FeO}, \text{Fe}_2\text{O}_3$) with a volume of 22·7, but $12\text{FeO}, 12\text{Fe}_2\text{O}_3=(\text{Fe}_{12}\text{fe}_{36}, \text{O}_{48})$ with a volume of $22·7\times12=272·4$, and so on. Rhombohedral and octahedral specular iron have about the same sp. gr., and if we assume their volume to be the same, we have a transition to another system without change of volume; we have for *Corundum*, $15·5\ \text{Al}_4\text{O}_4=(\text{Al}_{62}\text{O}_{62})$ with a volume of 268·5, and homologue of $(\text{M}_{48}\text{O}_{48})$ or magnetite. So *Polybasite*, in which copper in a double equivalent Ȼu, enters, (as I have been able to prove,) *is accurately represented by* $8(\text{Ag}, \text{Cu})\text{S}+(\text{Sb}, \text{As})\text{S}_4=\text{M}_8\text{Sb}, \text{S}_{12}$: but its sp. gr. corresponds to $(\text{M}_{16}\text{Sb}_2\text{S}_{24})$ with a volume of 270. Quartz (silica being SiO) is $\text{Si}_{25}\text{O}_{25}$, at. vol. 267. [Mr. Hunt proposes to present his views in detail in our next number.—J. D. D.]

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* [This apparatus is very nearly identical with the *vibrating armature* break-piece of Dr. Page and Daniel Davis, for more than ten years in use in all forms of electro-medical apparatus. The American contrivance has the additional convenience of an easy adjustment for the rapidity of its vibrations, offering every facility in the graduation of shocks.—Eds.]

II. CHEMISTRY AND PHYSICS.

1. *Stibmethylium and its Compounds.*—LANDOLT has communicated a second memoir on the compounds of antimony with methyl, which may be considered as ammonia or ammonium in which nitrogen is replaced by antimony and hydrogen by the radical methyl, C_2H_3. The iodid of stibmethylium $Sb\,Me_4I$, which forms the starting point of this investigation, is obtained by bringing stibmethyl, $Sb\,Me_3$, into contact with iodid of methyl, when the two soon unite to form the iodid as a white crystalline mass, easily purified by crystallization. If this iodid be distilled with antimoniuret of potassium in a vessel filled with carbonic acid gas, an oily liquid, heavier than water and igniting in the air passes over, which the author considers as the isolated radical stibmethylium $Sb\,Me_4$. Stibmethylium forms with one equivalent sulphur, chlorine, bromine, iodine or oxygen, compounds which possess the strongest analogy to those of potassium and ammonium. The oxyd is a powerful base intermediate in its properties between potash and ammonia and forming with acids both neutral and acid salts which appear to be isomorphous with the corresponding potash and ammonia compounds. These salts possess uniformly a bitter taste and with the exception of the sulphid are without smell. Potash and soda are the only bases which precipitate the oxyd of stibmethylium from its compounds. The presence of antimony is not indicated by reagents until the compound is completely destroyed. The salts of stibmethylium may be heated to 100° or 140° C. without change, unless the action of heat is long continued: heated to 180°–200° they begin to fume and then take fire and burn with a voluminous white flame. The compounds of stibmethylium exert no poisonous action on the animal economy; the author swallowed two grains dissolved in water without experiencing any ill effects. The oxyd of stibmethylium is prepared by treating a solution of the iodid with oxyd of silver, quickly filtering the liquid, and evaporating over sulphuric acid under the air-pump, when a white crystalline mass remains which is doubtless the hydrated oxyd. This substance behaves in all respects like caustic potash, is excessively caustic, gives when rubbed between the fingers the slippery feeling of the alkali, and attracts water and carbonic acid from the air. The carbonate effervesces strongly with acids. The solution of the oxyd expels ammonia from its salts and precipitates almost all metallic oxyds like potash.

The sulphid of stibmethylium is prepared like the sulphid of potassium and is an amorphous greenish powder of a strong odor of mercaptan, and soluble in water and alcohol. The formula is $Sb\,Me_4S$. The iodid of stibmethylium crystallizes in the hexagonal system and forms beautiful 6-sided tabular crystals. [It is therefore not isomorphous with iodid of potassium.—W. G.] The chlorid of the new radical crystallizes also in the hexagonal system, and the properties both of this salt and of the bromid resemble those of the iodid. With chlorid of platinum the chlorid of stibmethylium forms a beautiful orange-yellow crystalline powder represented by the formula, $Sb\,Me_4Cl + Pt\,Cl_2$. The sulphate of stibmethylium forms large colorless crystals which appear to belong to the right-rhombic system, and which have the formula, Sb Me_4O, SO_3+5 aq.; it is readily soluble both in water and alcohol. The author did not succeed in forming an alum with the sulphate of alumina. The bisulphate of stibmethylium forms beautiful hard colorless crystals which have the formula Sb $Me_4O.SO_3+HO.SO_3$. The author describes further a nitrate, carbonate, bicarbonate, oxalate, and acid tartrate, but gives no measurements by which to justify his statement that the compounds of stibmethylium appear to be isomorphous with those of potassium and ammonium.—*Journal für praktische Chemie*, lvii, 129.

2. *Note on the Kakodyl of Valerianic Acid.*—As the compounds of metals with organic radicals are becoming every day of more importance to the theoretic chemist, I am induced to mention in this place the results of some experiments made in November, 1849, on the formation of new organic compounds containing arsenic. When valerianate of potash is distilled with an equal weight of arsenous acid, a heavy oily liquid passes over into the receiver, slightly yellowish in color, and possessing a penetrating and highly offensive odor of garlic. With a solution of chlorid of mercury this liquid gives a thick white precipitate, while the odor of garlic disappears and is replaced by an agreeable aroma, like that of valerianate of oxyd of amyl. The oily liquid gave off thick white vapors in the air but did not inflame. Exposed for some time to the air in an imperfectly closed glass vessel it became completely converted into a mass of large brilliant hard four-sided prisms, which were nearly colorless, and after pressing with bibulous paper, free from smell. They had an acid reaction and may have been the valerianic compound corresponding to kakodylic acid. These crystals were readily soluble in water. In an attempt to unite them with oxyd of silver for the purpose of determining their constitution they were completely decomposed. The oily liquid obtained by the distillation above mentioned was soluble in water and appeared to reduce oxyd of mercury to the metallic state. It will be seen that the reactions of the substance in question in all respects resemble those of the butyric kakodyl obtained by Wöhler, and exhibit much analogy to those of the acetic kakodyl of Bunsen. The offensiveness of these compounds to non-chemical noses belonging to persons occupied in the same building with the writer, have hitherto prevented a further investigation of this subject, which it is to be hoped will engage the attention of chemists more advantageously situated.—W. G.

3. *Constitution of Spermaceti.*—HEINTZ has published in detail the results of his investigation of this subject—results which differ in many particulars from those obtained by other chemists. Spermaceti was saponified by boiling with an alcoholic solution of caustic potash. The solution was precipitated by chlorid of barium, and the baryta salts thus obtained freed from ethal by washing with alcohol which at the same time dissolved a portion of a baryta salt soluble in alcohol but insoluble in ether. The etherial solution also yielded a third baryta salt. Heintz studied separately an alcoholic solution from which the last named baryta salt was finally separated, the expressed ethal, and the three baryta salts. The ethal was found to possess the constitution assigned to it by Dumas, viz., $C_{32}H_{33}O+HO$. The alcoholic solution

from which the third baryta salt was separated, yielded a substance fusing at 10°–12° and having the formula $C_{18}H_{18}O_2$, which may possibly be the aldehyd of pelargonic acid. The fatty acids in combination with baryta were separated from each other by the method of partial precipitations employed by Heintz with so much success in his examination of human fat. In this manner five homologous acids were separated, viz., the cocinic, myristic, cetic, palmitic, and margaric acids, which exist in spermaceti in the form of salts of the oxyd of cetyl. Heintz terms these salts, cocäthal, myristäthal, cetäthal, palmäthal and margäthal. Their formulas are

Margäthal or margarate of cetyl,	$C_{32}H_{33}O+C_{34}H_{33}O_3$
Palmäthal or palmitate of cetyl,	$C_{32}H_{33}O+C_{32}H_{31}O_3$
Cetäthal or cetate of cetyl,	$C_{32}H_{33}O+C_{30}H_{29}O_3$
Myristäthal or myristate of cetyl,	$C_{32}H_{33}O+C_{28}H_{29}O_3$
Cocäthal or cocinate of cetyl,	$C_{32}H_{33}O+C_{26}H_{25}O_3$

Besides these compounds, however, spermaceti contains probably a small quantity of olein which is doubtless derived from the oil from which the spermaceti has crystallized. A second neutral substance was also obtained in small quantity: it was soluble in ether but only with great difficulty so in alcohol; its formula appeared to be $C_{28}H_{26}O_4$. —*Journal für praktische Chemie*, lvii, 30.

4. *Positive Photographic Pictures.*—Adolphe Martin has given a method of producing directly positive pictures upon glass, which appears to possess great advantages. Two grammes of cotton are to be converted into gun-cotton by a mixture of 50 gr. of nitrate of potash and 100 gr. of sulphuric acid: the product is to be well washed, dried, and dissolved in a mixture of alcohol and ether so that the solution shall contain for 1 gr. gun-cotton, 120 gr. ether, and 60 gr. alcohol. To this solution is to be added a mixture of alcohol and iodid of silver obtained by dissolving 1 gr. of nitrate of silver in alcohol and precipitating the solution with iodid of ammonium. The glass plate prepared in the usual manner and covered with a thin layer of this solution is to be dipped before drying into a bath composed of 1 part distilled water, $\frac{1}{12}$ of nitrate of silver and $\frac{1}{20}$ of nitric acid, and then exposed a few seconds in the camera. It is then to be dipped into a bath of sulphate of iron, and afterward carefully washed. The picture is now negative, but if it be dipped into a bath of the double cyanid of silver and potassium it becomes positive. It is to be washed, covered with a varnish of dextrin, dried, and framed upon a background of black velvet. The cyanid bath is that of Elkington and Ruolz, diluted with 3 vols. of water; it consists of 1 litre of water, 25 gr. of cyanid of potassium, and 4 gr. of nitrate of silver.—*Comptes Rendus*, xxxv, 29.

5. *Determination of arsenic in cases of poisoning.*—Van Kerckhoff has examined Schneider's method of determining arsenic by the volatilization of the chlorid—already described in this Journal, (xiv, 259)—and has found by quantitative experiments that a portion of the arsenic remains behind in the retort, so that the process can at best be but a qualitative one, and even from this point of view is inferior to that already in use.—*Journal für praktische Chemie*, lvi, 395.

6. *Cocinon, Myriston and Lauro-stearon.*—DELFFS has prepared and analyzed cocinon, and Overbeck, myriston and lauro-stearon. Cocinon, as prepared by the distillation of cocinate of lime, crystallizes in light, brilliant white scales; it is tasteless and without smell, is soluble in ether and alcohol, fuses at 58° C., and solidifies to a crystalline spermaceti-like mass. Its formula is $C_{42}H_{42}O_2$ or $C_{21}H_{21}O$. Myriston and lauro-stearon crystallize in brilliant white scales, and solidify on cooling after fusion in crystalline masses, which become highly electric by friction. Myriston has the formula $C_{50}H_{50}O_2$ or $C_{25}H_{25}O$, and fuses at 75° C. Lauro-stearon has the formula $C_{46}H_{46}O_2$ or $C_{23}H_{23}O$, and fuses at 66° C.—*Pogg. Ann.*, lxxxvi, 587, 591. W. G.

7. *On the Allotropic Modification of Oxyd of Cobalt;* by F. A. GENTH of Philadelphia, (communicated for this Journal by Dr. GENTH.) —One of my students, Mr. Edwin L. Reakirt, has discovered the allotropic modification of oxyd of cobalt, corresponding in all its properties with the allotropic modification of oxyd of nickel, which I detected several years ago.* It was obtained accidentally by the decomposition of the carmine chlorid of my cobalt bases, (Fremy's chlorhydrate de roseocobaltiaque,) by heat, and after dissolving out the chlorid of cobalt, it remained pure. It occurs in iron black, very brilliant microscopic octahedra, with a submetallic lustre. They are not magnetic. They are insoluble in hydrochloric or nitric acid, but readily dissolve by fusion with bisulphate of potash. The quantity obtained was too small for further examinations; but judging from analogy, there is no doubt as to its composition. It contains no nickel. By the decomposition of the above mentioned salt, I have often obtained metallic cobalt, but never before this oxyd. I will mention here, that I have several times observed the allotropic modification of oxyd of nickel, in quantities not exceeding 0·5 or 1·0 in the metallic nickel manufactured in Hesse-Cassel and imported to this country.

8. *Observations on the Zodiacal Light made at the Kew Observatory from January to April*, 1850; by Mr. H. R. BIRT, (Proc. Brit. Assoc., 1852, Ath., No. 1298.)—These observations were made at the Observatory of the British Association during the author's residence there. It appeared to the author that two very important features presented themselves in connection with the observations:—viz., the *position* of the great mass of light being constantly *north* of the ecliptic,—and, the apparent change in the *form* of the light, or at least that portion of it forming the apex of the luminous triangle on the cone of light, which is very perceptible in the groups of observations, those in February presenting a narrower cone, the axis being very perceptibly *inclined* to the ecliptic. In this respect these observations are in decided contrast with those of March, when the cone of light had become much larger, the apex more rounded, and the inclination of the axis to the ecliptic changed. It would appear from the projections that accompanied the observations, that while the great mass of light was still northward of the ecliptic the direction of the axis was so inclined that it occupied a *different* position with respect to the ecliptic than it did in February.

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* Ann. der Chem. und Pharm., 53, p. 139.

In the month of April the author considered the axis of the zodiacal light to be slightly north of the ecliptic, the *northern* side of the cone still exhibiting the greatest luminosity. The contrast of the observations in this month (April) with those in February, is very remarkable;—the cone had become very considerably enlarged, and consequently much broader than the cone seen in February. Two observations, those of March 3 and April 10, were particularized as indicating that under peculiar circumstances *we see more of the zodiacal light* than is presented to us ordinarily. In connection with these phenomena the author observed earlier in March a sudden brightening of the light for an instant, and also variations in its lustre of an intermittent character. These intermissions of brightness were observed on the same evenings by Mr. Lowe, at Nottingham. They are described by the author not to be of the nature of pulsations in the usual acceptation of the term, but to consist of alternate brightenings and dimmings of the entire mass of light such as might be produced by the approach and recess of a luminous body.

9. *On the Form of Images produced by Lenses and Mirrors of different sizes;* by Sir DAVID BREWSTER, (Proc. Brit. Assoc., 1852, Ath., No. 1298.)—The object was, to show that the photographic portraits taken with cameras with large object-glasses or large mirrors must necessarily be distorted and hideous, as in fact it is notorious they are; and that hence all persons engaged in this new and most important art should receive with gratitude any scientific discovery which promised to correct so serious a defect—which by some has been attributed to the imperfection of the lenses employed,—by others to the unsteadiness of the sitter who is having his portrait taken,—by others, again, to the constraint of features and limb under which he submits to the operation; but it is by all admitted and deplored. If we consider that the pupil of the human eye is only about $\frac{2}{10}$ths of an inch in diameter, it is obvious that the images formed by the eye of those solid objects placed in front of it, and by which we are accustomed to see them, to judge of them, and to recognize them, cannot embrace any of the rays of light which come from those parts of the object which lie in such positions towards the sides, top, bottom or hinder parts as cannot pass in straight lines to an aperture of the size of the pupil,—in fact, unless it agree almost exactly with the exact perspective form of the object, the pupil being the point of sight. If then an object be placed before a lens, the part of the lens towards its centre, of the size of the pupil, is capable of forming a correct image of that object, consisting of rays coming from precisely the same parts of it as an eye would receive were its pupil in the same position. But all the parts of the lens or mirror of the same size which lie around and at a dtstance from this portion of it, would receive rays coming from parts of the solid object which the true eye could not receive, and which must therefore form as many unnatural images as there were such parts; and the photographic picture which embraces and confounds into one hideous mass all these, any one of which by itself would be correct, must in the very nature of things give a most confused and displeasing representation of the object. Sir David illustrated and proved these assertions by a diagram of a lens with a simple solid form, a cylinder topped by a cone behind,

placed in front of the lens, pointing out the parts which alone could be embraced in a correct perspective view of it, and what parts the large lens or mirror would moreover receive and transmit rays from, to be jumbled in the photographic picture with that which would alone give a correct idea of the object as seen. He showed from the now familiar illustration afforded by the binocular stereoscope, how very dissimilar were the pictures of the same object received by small lenses placed as near as the two pupils of the human eye; images so distinct that a child could readily distinguish them; and yet multitudes of such images were all received and jumbled together in those photographic pictures where lenses or mirrors of that or larger—say three or four inches—aperture were used. "The photographer, therefore," said Sir David Brewster, "who has a genuine interest in the perfection of his art will, by accelerating the photographic processes with the aid of more sensitive materials, be able to make use of lenses of very small aperture, and thus place his art in a higher position than that which it has yet attained. The photographer, on the contrary, whose interests bribe him to forswear even the truths of science, will continue to deform the youth and beauty that may in ignorance repair to his studio, adding scowls and wrinkles to the noble forms of manhood, and giving to a fresh and vigorous age the aspects of departing or departed life." He then produced an exact diagram of photographic images of a simple object produced by Mr. Buckle of Peterborough, whose Talbotypes obtained a Council Medal at the Great Exhibition. The acting diameter of the lens was $3\frac{1}{8}$ inches; and by using it with all covered, except a central space of $\frac{2}{10}$ths of an inch diameter, and then along with this space exposing circular spaces of the same size towards the outer circumference of the aperture, the effect of the combination of the marginal pictures was most distinctly exhibited and demonstrated, by halos extending round the true image, and the sharp cross lines ruled on the object and shown in the image with the small lens, but all confused in that with the surrounding apertures.

10. *On a Rock-Crystal Lens and Decomposed Glass found in Nineveh;* by Sir David Brewster, (Proc. Brit. Assoc., Athenæum, No. 1298.)—Sir David said that he had to bring before the Section an object of so incredible a nature that only the strongest evidence could render the statement at all probable:—it was no less than the finding of a rock-crystal lens, in the treasure-house at Nineveh, where it had for centuries lain entombed in the ruins of that once magnificent city. It was found in company with several bronzes and other objects of value. He had examined the lens with the greatest care and taken its several measurements. It was not entirely circular in its aperture, being $1\frac{6}{10}$ths inches in its longer diameter and $1\frac{4}{10}$ths inches in its shorter. Its general form was that of a plano-concave lens, the plane side having been formed of one of the original faces of the six-sided crystal of quartz, as he had ascertained by its action on polarized light,—this was badly polished and scratched. The convex face of the lens had not been ground in a dish-shaped tool in the manner in which lenses are now formed, but was shaped on a lapidary's wheel, or in some such manner. Hence it was unequally thick, but its extreme thickness was $\frac{2}{10}$ths of an inch, its focal length being $4\frac{1}{2}$ inches.

It had twelve remains of cavities which had originally contained liquids or condensed gases; but ten of those had been opened probably in the rough handling which it received in the act of being ground; most of them therefore had discharged their gaseous contents. Sir David concluded by assigning reasons why this could not be looked on as an ornament, but as a true optical lens.

Sir David then exhibited specimens of the decomposed glass found in the same ruins. The surface of this was covered with iridescent spots more brilliant in their colors than Peacock copper ore. Sir David stated that he had several years since explained how this process of decomposition proceeded, on the occasion of having found a piece of decomposed glass at St. Leonard's. It had contained manganese, which had separated from the silex of the glass, at central spots around which circles of most minute crystals of true quartz had arranged themselves; bounded by irregular jagged circles of manganese, these being arranged in several concentric rings. When this process reached a certain depth in the glass it spread off laterally, dividing the glass into very thin layers, and new centres seemed to form at certain distances, and thus the process extended.

11. *On Magnetism and Diamagnetism;* by Prof. MATTEUCCI, (Proc. Brit. Assoc., Ath., No. 1299.)—The author examined the influence of high temperatures and of compression on several substances. Iron, when passing from ordinary temperatures to a fusing heat, under the action of the oxyhydrogen blowpipe suspended by cocoon silk by a piece of caustic lime or a horizontal bar of copper wire in the magnetic field of a powerful electro-magnet, suffered a diminution, in one sufficiently exact experiment, of at least fifteen million times. All the compounds of iron and all natural substances containing a portion of metallic iron suffer a diminution by heat. Hence it is that all the natural and artificial compounds of magnetic and diamagnetic substances, such as certain coals and charcoal, impure metals, gold, copper, zinc, &c., which are attracted at ordinary temperatures, appear to be temporarily repelled when strongly heated. The repulsive action of diamagnetic substances suffers a very slight diminution by fusion. But this is not the case with bismuth, with respect to which the author had verified and completed the observation of Plücker. The Professor then detailed experiments proving this. He had also examined the influence of violent mechanical compression on magnetic and diamagnetic substances:—for instance, by means of a copper box furnished with a screw, he compressed a cylinder of bismuth 3 millimeters diameter and 34 millimeters long to 28 millimeters, and found it had when compressed a diamagnetic action distinctly superior to that of its natural state. He had confirmed the fact discovered by Coulomb, and more recently by Plücker, that the oscillation of bismuth and of other feebly magnetic substances was independent of their weight,—or, in other words, that the diamagnetic power is proportionate to the weight of the cylinder. He had also examined the influence of powerful electro-magnets on chemical affinity and on cohesion, and given several detailed results. He has studied the influence of the magnetic power of the elements on that of the body resulting from their combinations. Although some elements which are diamagnetic have magnetic compounds, such as the proto-

chlorate of copper, he found that in general the magnetical character of the compound results from that of its elements. He has made a number of experiments on the laws of equilibrium of diamagnetic bodies in the magnetic field, and on the reciprocal action of diamagnetic bodies; the methods of observing used being simple and ingenious, chiefly by observing the change of form or the curve of the common surface of one fluid when floating on another. He passed over many other topics with brief notice; and concluded with calling Prof. Faraday's attention to what he believes to be the most important fact of these researches, and which relates to an experimental theory of diamagnetic phenomena. We abstain from publishing a full abstract, as the author wishes himself to arrange these researches before publication.

12. *On a Manifold Binocular Camera;* by A. CLAUDET, (Proc. Brit. Assoc., Ath., No. 1299.)—The author exhibited a Double Camera for taking the two stereoscopic daguerreotypes of groups or individuals,—and by which four double pictures could be successively taken with such rapidity as to be exact representations of the same circumstances. It would be impossible to make all the mechanical arrangements of this instrument intelligible without drawings. The author also exhibited an instrument, which he called a stereoscopometer; by which he could accurately measure the angles, by which could be determined the place of the group or figure to be taken, and the position in every one of their adjustments of the double camera and its slides.

13. *On Poisson's Theoretic Anticipation of Magno-crystallic Action;* by Dr. TYNDALL, (Proc. Brit. Assoc., Ath., No. 1299.)—In an article in the *Phil. Mag.* for March, 1851, Prof. W. Thomson had drawn attention to the fact that Poisson had theoretically anticipated the discovery of magno-crystallic action by Plücker; and, in the latest number of the "Annual Report of Liebig and Kopp," Dr. Tyndall's investigations are referred to as especially corroborating the above view. Highly as he prized the support and coincidence of Prof. Thomson on a scientific subject, he must decline subscribing to his views in the present instance; and he thought he would prove that the theory of Poisson was unsuited to explain the phenomena of magno-crystallic action. By means of a powerful electro-magnet, Dr. Tyndall had been enabled to prove each of his statements by actual experiment. Poisson supposed a magnetic body to be an assemblage of magnetic molecules, and in the case of certain crystalline bodies, he imagined that these molecules possessed an ellipsoidal shape. Supposing such a body to be magnetized in a certain direction, and all these ellipsoids to lie with their longer axes in the same direction, the attraction of such a body parallel to these longer axes would be different from its attraction in a transverse direction. A differential action, such as that here indicated, was certainly established by the experiments of Prof. Faraday and Dr. Tyndall; but its cause is not to be referred to the shape of the molecules, as supposed by Poisson. A crystal of calcareous spar was hung in the magnetic field, and its action exhibited,—its optic axis set equatorial. A model of white wax of the same shape and size as the spar, and at first sight almost to be mistaken for a crystal, was hung in the magnetic field, and exhibited a precisely similar action—its axis was also set equatorial. A crystal of carbonate of iron was next examined,—its axis set from pole to pole; a magnetic model of the crystal did the same. Dr.

Tyndall then proceeded to show that a bar of magnetic or of diamagnetic matter might be caused to set axal or equatorial, by simply varying its point of suspension. The experiments were closely watched by Prof. Thomson, who certified the success of every one of them. "Now," proceeded Dr. Tyndall "we have here two substances, exactly alike in exterior shape,—one a crystal built by nature, the other a model constructed by myself; you have seen that the actions of both are identical,—the one is not to be distinguished from the other. Whatever explains the deportment of the model must explain that of the crystal also. This piece of wax is composed of material particles; now I ask, what must the effect be if I squeeze this wax between two plates? will it not be to bring the particles more closely together along the line on which the pressure is exerted? This is simply what has been done in the case of the model, and this peculiar arrangement of its particles (without reference to their *shape*) produces the effects which you have witnessed. Now, the action of the model comes under the head of magno-crystallic phenomena, and we see that the theory of Poisson is totally inadequate to its explanation. Magno-crystallic action is thus proved to be due, not to the shape of the ultimate molecules, but to their manner of arrangement."

14. *Examination of Dove's Theory of Lustre*; by Sir David Brewster, (Proc. Brit. Assoc., Ath., No. 1300.)—The author explained the theory of Dove, which, if we took him correctly, was, that the lustre of bodies and particularly the metallic lustre arose from the light coming from the one stratum of the superficial particles of bodies interfering on the eye with the light coming from other and deeper strata,—the regular symmetrical arrangement of the particles in these bodies producing effects somewhat analogous to that of mother-of-pearl. But the opinion which Sir David himself seemed to incline to, was, that since we know from the phenomena of very thin metallic leaves that lights of very different colors are transmitted through strata of different kinds of matter and of different thicknesses, and since from the different refrangibility of lights of these colors, the same lens will not bring them to a focus at the same distance,—metallic lustre was caused by the effort used to accommodate the eye to the distinct vision of these colors. He illustrated this by the effects produced when the two figures of a binocular stereoscope were colored with complementary colors, and viewed together in the instrument.

15. *Notice of a Tree struck by Lightning in Clandeboye Park*; by Sir David Brewster, (Proc. Brit. Assoc., Ath., No. 1300.)—The tree stood in a thick mass of wood, and was not the tallest of the group. The lightning bolt struck it laterally about 15 feet above the ground, exactly at the cleft where the two principal branches rose from the trunk. A large part of the bark and a piece of the solid wood were driven to some distance, and the electric fluid passed down the trunk into the ground, splitting the tree in two by a rent through the whole of its thickness. The fact contained in this notice, that an object may be struck by lightning in a locality where there are numerous conducting points more elevated than itself, shows that a lightning bolt cannot be diverted from its course by conductors, and that the protection of buildings from this species of meteor can only be effected by conductors stretching out in all directions.

III. GEOLOGY.

1. *On the Connection between Geological Theories and the Figure of the Earth;* by Mr. H. HENNESSEY, (Proc. Brit. Assoc., Ath., No. 1299.)—As Geology may be considered to embrace an examination of the form and structure of the earth, it follows that every correct geological theory must be capable of explaining the greater as well as the lesser inequalities in the figure of our planet. Certain geological theories being incompatible with the supposition that the earth was originally in a state of fluidity, attempts have been made to account for its spheroidal figure by the abrading action of the waters at its surface. It has been shown by Playfair and Sir John Herschel that the earth would from such causes ultimately tend to assume the form of an oblate spheroid; but neither of these eminent mathematicians has presented such numerical results as would enable us satisfactorily to compare the theory with observation. This the author has effected in a paper communicated to the Royal Irish Academy, in which he deduces for the polar compression according to the theory in question $\frac{1}{404}$. The compression given by measurements is $\frac{1}{300}$; consequently, it seems that the theory of the earth's primitive solidity must be rejected in favor of that of its primitive fluidity, which agrees with observation. The author also pointed out an inconsistency in the theory of climates proposed by Sir Charles Lyell in order to account for the diminution of temperature at the earth's surface since early geological epochs. This theory would require a gradual transport of matter from the equator to the poles, in order to account for a diminution of the heating surface of dry land at the equator. Consequently, on this theory, the earth would tend to become prolate instead of oblate. The author concluded by pointing out similar objections to the geological views known as the Neptunian theory and the chemical theory of volcanoes.

2. *Geology and Palæontology of a part of the Rocky Mountain Region;* by Prof. J. HALL, (from Capt Stansbury's Expedition to the Great Salt Lake, p. 401.)—This report is made out from the specimens collected by Capt. Stansbury and the notes taken in the course of his expedition. We insert here some extracts.*

"The first specimens furnished are from the west side of the Missouri River, near and above Fort Leavenworth, (39° 21′ N., 94° 44′ W.) These are all from limestone of the *carboniferous* period, and apparently from the upper of the two great limestones of this period in the west. The most conspicuous fossils are *Productus*, *Terebratula*, &c.

The route from the Missouri westward shows a continuation of this limestone as far as the Big Blue river, (40° N., 96° 40′ W.)

Here it disappears, judging from specimens and remarks in the notes. It is soon succeeded by strata of *cretaceous* age, which, from the speci-

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* The route of Capt. Stansbury was from Fort Leavenworth on the Missouri, in 39° 21′ N., 94° 44′ W., up the Missouri and Platte to Fort Kearney, in 40° 39′ N., 98° 58′ W.; up the North Fork of the Platte to Fort Laramie, in 42° 12½′ N., 104° 31½′ W.; still west on the same Fork, leaving it for the tributary called the Sweet Water in 42½° N., 107° 10′ W., and thence to the southward and westward through the South Pass to the south side of the Salt Lake where (in 40° 46′ N., 112° 6′ W.,) the Mormon city is situated.

mens preserved, I have been able to recognize as extending for a considerable distance on the route between Turkey Creek and Big Sandy.

Among the cretaceous fossils are a species of *Pholadomya*, and the *Inoceramus*, which is so abundant in numerous localities in this region. It is quite probable that these beds extend much farther, but I find no specimens in the collection; and the notes indicate that there are heavy deposits of drift, which may have covered the formation below." * *

"It would appear that the character of the country from near Fort Kearny to near Fort Laramie is uniform, and that no deposits of older date than the tertiary were observed. Of the specimens collected there is but a single individual indicating the character of a marine formation. From the condition of the bones it may even be questioned whether the deposit containing them is not of post-tertiary age.

The specimens from the vicinity of Fort Laramie are all from limestone of the *carboniferous* period. Some of the fossils are identical with species collected between the Missouri and the Big Blue, and we can only suppose, from the great similarity of the specimens, that it is a continuation of the same formation. From the dates marked upon the specimens, it is evident that this limestone extends to some distance on the east and west of Fort Laramie.

The specimens bearing date of July 19th, two days' march northwest of Fort Laramie, (105° W.,) are a feldspathic granite with little quartz or mica. The rocks in this locality are doubtless of metamorphic origin, probably rocks of Silurian age. The specimens collected three days' march in advance of this place, (105° 25′ W.,) are shaly sandstone and thinly laminated sandstones containing fossils. The fossils are some brachiopods, with others similar to *Monotis*, and we may presume from the described position of the beds, and from the character of the fossils, that these beds are of Devonian age. In the journal these beds are recorded as dipping at the rate of 15° to the northeast.

The specimens bearing the mark of July 24th, (105° 50′ W.,) are precisely like those collected at Fort Laramie, and contain the same species of fossils. On the same date were seen (according to the journal) gray and red sandstones. On the following day (near 106° W.,) is recorded a bed of coal, three or four feet thick, with *Sigillaria* and *Calamites*. The specimens of this date sent to me are those of bituminous coal and others of soft shale, but without any well-marked vegetable remains.

From the proximity of limestone of the age of the coal, and the record of Sigillaria and Calamites occurring in the same connection, it may be presumed that this coal belongs to the true coal measures; and this locality is probably an exposure indicating the existence of a great basin. This point itself and the surrounding country are well worthy of a more extended examination, since the discovery of workable beds of coal in this region would be a matter of national importance.

The record of July 27th (106° 45′ W.,) shows the occurrence of red shales and sandstones, which may be of the age of the coal, or beneath that formation." * * * "From the Wind River Mountain to Ft. Bridger (in 41° 18′ N., 110° 32′ W.,) the collections are all of *marine tertiary*, including many specimens of *nautilus* and others marine shells." "West of Fort Hall (43° N., 112½° W.,) are chert and limestone of carboniferous age."

"The specimens collected in the islands and shores of the Great Salt Lake are sufficient to give one a very good idea of the general geological features. The specimens are of metamorphic rocks, consisting of talcose and mica slates, hornblende rocks, and a few specimens of granitic or syenitic character.

Some specimens of the latter description occur along the valley of Ogden's River. Antelope Island, Frémont Island, a part of Promontory Point, and Mud Island, on the east side of the lake, judging from the numerous specimens, consist principally of talcose and mica slates, with hornblende rock. Carrington Island, Hat Island, a point north by west from Hat Island, name not known, and a part of Strong's Knob, consist of similar rocks with some of altered sandstone or quartz rock. In several localities, as at Promontory Point and near Mud Island, the metamorphic strata appear to be overlaid by a coarse conglomerate, or coarse sandstone, which is partially altered, and assumes the character of a quartz rock.

From all the facts in my possession, it would appear that these metamorphic rocks are distinctly stratified and highly inclined, but do not attain any great elevation. The direction of the ranges, corresponding to that of the elevating forces, appears nearly to conform to north by west and south by east. From the form of the lake and the different localities at which rocks of this character occur, we may infer that there were two lines of elevation, corresponding with the divisions of the lake.

The more elevated portions of the lake shore, and the mountain ranges, consist of carboniferous limestone. In some localities this limestone is partially altered, losing its granular character and becoming sub-crystalline, or threaded by numerous veins of calcareous spar. In most localities, however, the limestone abounds with fossils, particularly corals of the Cyathophillidæ." * * *

"Although I have not felt at liberty to color on the map any other points than those indicated both by the notes and by specimens examined, yet I can have no doubt that all the elevated ranges on the west, south, and north of the Great Salt Lake are capped by the carboniferous limestone. Judging from the relative position of the limestone, and the metamorphic rocks of Antelope and Frémont's Islands, the former occupies the position of low, synclinal basins, the valleys between being produced to a large extent probably by erosion along the anticlinal axes, occasioned by the elevation of the metamorphic beds. We may expect, also, that the same limestone will be found upon the elevated plateaus and mountains on the east side of the lake.

It will be seen from these facts that we have very satisfactory information that this *limestone of the carboniferous period* is widely distributed in the region around the Great Salt Lake. Its position relative to the coal-bed on the North Fork of Platte River has not been determined; but since no beds of coal have been observed on the slopes of the mountains in the region of the Salt Lake, we are left to infer that the coal is to be sought (as elsewhere) above the limestone. Since the existence of coal is proved in one point, (admitting the evidence in favor of its age being that of the carboniferous period,) we are warranted in the conclusion that it once existed over a much wider area, and can be sought with success in the proper situations. The importance of this mineral in that distant region cannot be too highly estimated, and the geographical position and extent of the beds should be one of the first points ascertained in the location of any route of communication between the east and the west."

The Report contains also descriptions and figures of various fossils, mostly from the carboniferous rocks, being species of several corals, Brachiopoda, (one species of Terebratula, three of Productus, three of Spirifer, one of Chonetes, one of Orthis,) a few acephala, besides a Pleurotomaria and a Euomphalus, in all 14 new species. One species is the *Chonetes variolata* of Koninck.

3. *Geological Survey of Canada:* Report of Progress for the year 1851–2; by W. E. LOGAN, Provincial Geologist. Printed by order of the Legislative Assembly. 121 pp., 8vo. Quebec, 1852—In our last volume we gave a notice of some of the important results of Mr. Logan's survey. The Report here issued dwells mostly on the discoveries of economical value. He states that the whole amount of gold for the season, (about five months) obtained in the Chaudiere region on the R. de Loup, was 1900 pennyweights. *Phosphate of lime* in nodules is disseminated in rocks of the lower Silurian age at several localities. The amount of phosphoric acid present was ascertained by Mr. T. S. Hunt, chemist to the Survey, (p. 105 of the Report) who found in some of them—

	I. R. Ouelle. Sandstone.	II. R. Ouelle. Conglomerate.	III. Lac des Allumettes. Sandstone.	IV. Glenville. Sandstone.
$\dot{Ca}^{3}\,\bar{P}$,	67·53	40·34	36·38	44·70
$\dot{Ca}\,\ddot{C}$,	4·35	5·14*	5·00*	6·60
$\dot{Mg}\,\ddot{C}$,	1·65	9·70	7·02 (diff.)	4·76
$\dot{Fe}$,	2·95	$\bar{Fe}$, 12·62†		$\bar{Fe}$, 8·60‡
Insol. sand,	21·10	25·44	49·90	27·90
Vol. matter, $\dot{H}$,	2·15	2·13	1·70	5·00
	99·73	95·37	100·00	97·56

The nodules are of various shapes, sometimes as observed by Mr. Hunt at the river Ouelle in hollow cylinders (I), sometimes in nodules or globular masses more or less flattened, (II, III,) at times appearing compact, like worn fragments of slate (IV). Mr. Hunt suggests that they are remains of bones or coprolites, though with hesitation, as this implies the existence of Vertebrata during the Lower Silurian epoch. Other information in this report we defer to another number.

IV. BOTANY AND ZOOLOGY.

1. *Carices Americæ Septentrionalis exsiccatæ.* Edidit H. P. SARTWELL, M.D. Pars 1–2. Penn Yan, Nov. Ebor. 1848–50.—These two volumes consist of actual specimens of 158 species and varieties of the genus *Carex*, finely prepared, and arranged by Dr. Sartwell with great neatness and care. The specimens are, for the most part, collected by himself, in his immediate neighborhood, where very many species are found; but Dr. Sartwell has taken the utmost pains, by cor-

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* With some fluorid. † With a little $\bar{Al}$ and a trace of $\dot{Mn}$. ‡ With a trace of $\bar{Al}$.

respondence with botanists throughout the Union, to obtain from them the species peculiar to their respective localities; and has thus been enabled to include, in his two parts, rather more than a quarter of the known species of this vast genus; of which representatives are found in almost every part of the globe.

The time and exertion requisite for such a work as this of Dr. Sartwell, can only be estimated by the practical collector, who has toiled through bog and brake, "from morn till dewy eve," loaded with his folios and collections. But the search for the various species, though arduous, constitutes only a small part of the needful labor, since the drying and preparation of specimens, so beautiful as those before us, is a matter requiring much time and care; even in the case of so practised a hand as Dr. Sartwell. No reasonable price would be a compensation for the production of such volumes, and hence they rarely appear, except when offered as labors of love, and gratuitously distributed, as in the present instance. Dr. Sartwell has, for many years past, taken an especial interest in these plants, and having observed them with an acutely discerning eye, has selected and arranged his specimens with great accuracy. Each species occupies a separate sheet, to which is appended a printed label with number, name and synonymes, place of growth, and name of collector, when derived from other hands than his own. The numerical order of the specimens is that of Dr. Gray's Manual of Botany, following which, we shall briefly remark on a few of the species.

"No. 1. *C. dioica*, L."—This is *C. gynocrates*, Wormsk., and though very closely resembling C. dioica, differs from that species in several particulars; especially by the shorter, loosely-flowered spikes, and the lanceolate, *diverging* perigynia, which are less distinctly nerved, and smooth, or very slightly serrulate on the beak. C. dioica is probably confined, on this continent, to Arctic America and the Rocky Mountains.

"No. 12. *C. Sartwellii*, Dew."—This plant, first collected in New York, by Dr. Sartwell, was dedicated to him by Professor Dewey, some years since; but it does not appear to possess any sufficient characters by which it can be distinguished from No. 71, *C. disticha*, Huds.; a very variable species, in different localities and stages of growth.

"No. 14. *C. prairea*, Dew."—If this is specifically distinct from *C. paniculata*, L, (which is very doubtful,) it will probably have to bear the prior name of *C. Ehrhartiana*, Hoppe, to which it has been referred by Dr. Boott.

"No. 21. *C. cephaloidea*, Dew.," appears to be only a stouter form of No. 22, *C. cephalophora*, Muhl.; but No. 75 (from Illinois) is, doubtless, the plant of Dewey, which is scarcely distinguishable from No. 20, *C. sparganioides*, Muhl., except from its inferior size.

"No. 29. *C. gracilis*, Ehrh."—Dr. Boott has ascertained, from an authentic specimen, that this name belongs to *C. loliacea*, L. Hence, that of Schkuhr, *C. tenella*, will attach to this species, commonly known to American botanists as *C. disperma*, Dew.

"No. 33. *C. sphærostachya*, Dew.," if distinct from *C. canescens*, L., must bear the prior name of Fries, *C. vitilis*.

"No. 40. *C. Liddoni*, Boott," is surely nothing more than a small form of No. 11, *C. siccata*, Dew. Dr. Sartwell's plant, though entirely different from that of Boott, which is probably confined to the N. W. coast, is, however, the C. Liddoni of Dewey, (Wood's Botany,) and of the writer, (Gray's Manual of Botany.)

"No. 48. *C. straminea*, Schk.," scarcely differs from No. 77, *C. alata*, Torr. and Gr., except in the rather inferior size of the spikes. Three other varieties of C. straminea are given in No. 76.

"No. 49. *C. straminea*, Schk., *var. moniliformis*, Tuck," is *C. adusta*, Boott, a species approaching very near to No. 44; which is generally understood, though without absolute certainty, as *C. festucacea*, Schk.

No. 51, is correctly, though doubtfully, referred to *C. torta*, Boott.

"No. 53. *C. acuta*, L., *v. erecta*, Dew., *C. aperta*, Boott?" This appears to differ from Boott's plant, principally in the smaller size of the spikes, and it would be difficult to distinguish them by any intelligible characters. *C. acuta*, L. has not been found on this continent.

"No. 55. *C. strictior*, Dew.," does not seem to be specifically distinct from No. 54, *C. stricta*, Lam.; a name which must, assuredly, be continued for the American plant, since the species was originally founded, by Lamarck, on specimens from "Virginia and Pennsylvania;" whereas, the C. stricta of Goodenough, and of European botanists generally, has never been found on this continent.

"No. 57. *C. salina*, Wahl.?" is also a form of *C. stricta*, Lam., with curved and misshapen perigynia. It is referred, by Gay, to C. verrucosa, Freedl.

"No. 91. *C. Careyana*, Dew.," should have been ascribed to Dr. Torrey, in correspondence with the original description by Professor Dewey.

"No. 130. *C. Houghtonii*, Torr.?" is not Torrey's plant. It is, perhaps, a hairy-fruited form of No. 129, *C. striata*, Mx.

"No. 146. *C. lupulina*, Muhl." The name of *C. gigantea*, Rudge, is here, erroneously adduced as a synonyme. C. gigantea is distinguished, from all its immediate allies, by the *spreading* perigynia, and several (2–5) barren spikes; more nearly resembling *C. retrorsa* Schw. than C. lupulina.

It is probable that botanists may differ from Dr. Sartwell as to some forms which he regards as distinct species; but this is matter of small moment, and those who are so fortunate as to possess a set of his valuable exemplars, will have the best opportunity for study and comparison. It is, indeed, to be regretted that these beautiful specimens cannot, in the very nature of the case, be so widely diffused as might be desired, more especially among European botanists; since the difficulty of assigning arbitrary specific characters to the species of so vast and intricate a genus, leads, unavoidably, to many misapprehensions, which the generous labors of Dr. Sartwell are better calculated to correct, than the best possible verbal descriptions. J. C.

2. *J. G. Agardh, Species Genera, et Ordines Algarum.* Lund., 8vo, vol. i, 1848. Vol. ii, pars. 1, 1851; pars. 2, 1852.—The second part of the second volume of this elaborate and excellent work has appeared since the brief announcement in a former number of the Journal (vol. xiii, p. 53.) Professor Harvey's great work on the North American Algæ, published by the Smithsonian Institution, has awakened so much interest in the study of Algæ, that many of our readers may be glad to

know that the most trustworthy general treatise on the whole family, or *kingdom*, as Professor Agardh terms it, is making rapid progress towards completion. The first volume (362 pages) contains the *Fucoideæ* complete. The two parts of the second volume (720 pages) include 13 of the 16 orders, as they are called, of the *Florideæ*, or rose-red Algæ, or all except those of Agardh's series *Desmiospermeæ*, subseries *Corynospermeæ*. It was only in 1824 that the system Algarum of the older Agardh was published, which comprised characters of all the Algæ then known, both of salt and fresh water, in a single small 18mo volume, of 312 pages. A. G.

3. *L. R. Tulasne*, *Monographia Podostemacearum.* (Excerpt. e tom. vi, Archiv. Mus. Hist. Nat.) Paris, 1852, pp. 208, imp. 4to, with thirteen plates.—This is an admirable monograph of a remarkable able and anomalous family of aquatic Dicotyledoneous plants, most of which imitate the Sea-weeds, Liverworts and Mosses in their organs of vegetation. Our own single representatives in the United States, and from which the order takes its name, was the earliest known to botanists, having been detected in Virginia by Barrister, and by him sent to Plukenet; although many years elapsed before it was described in Michaux's Flora Boreali-Americana, under the name of *Podostemon ceratophyllum.* Meanwhile a related plant had been discovered in Guiana by Aublet, his *Mourera fluviatilis.* Two other South American species were found by Humboldt; and a number of Brazilian species, belonging to two or three new genera were discovered by Martius, St. Hilaire, and Riedel. Meanwhile Petit-Thouars had made known three new genera of the order from Madagascar. In recent times the number of known species has largely increased, chiefly through the researches of the late Dr. Gardner, in Brazil and in Ceylon, and of Mr. Weddell, in the interior of South America. Bongard reduced the known genera to three; one of which, his *Philocrena*, proves to be the same as the *Tristicha* of Thouars. Endlicher admits six genera. Tulasne has now raised the number to twenty; and has described about eighty species. They are all tropical, with three exceptions; namely *Tristicha Dregeana*, and *Sphærothylax algiformis*, of the Cape of Good Hope, and our own *Podostemon ceratophyllum*, which extends north even as far as to the tributaries of the St. Lawrence. (At least I have it from the Black River, the most eastern stream flowing into Lake Ontario, on the southern side.) About two-thirds of the whole belong to South America, east of the crest of the Andes. Tulasne gives an account, first of the anatomy and organography of the plants of this order, with full details; and then considers the question of their affinity. On this point (beyond the indisputable fact that they are dicotyledoneous plants, notwithstanding that Martius and Bongard took the opposite view) he arrives at no more definite conclusion than his predecessors; but he hazards the conjecture that they may be reduced representatives of Lindley's Geranial Alliance; just as Myriophyllum and Hippuris are reduced Onagraceæ. As to useful properties, it appears that the *Marathra* of New Grenada are greedily eaten by cattle, who seek for them in the rocky river-beds when the waters fall. On the upper waters of the Amazon certain Podostemaceæ are largely eaten by the natives, as is the *dillisk* and *sloke* in Ireland and Scotland. Mr. Spruce, in a letter

just published, (in the October number of Hooker's Journal of Botany,) briefly states that "the Podostemata that grow on the falls are a chief article of support to the natives for one half of the year." Tulasne arranges the genera according to progressive complexity, or perfection of floral structure; beginning with those that are diœcious (*Hydrostachys*,) or androgynous, and destitute of floral envelops, and ending with those that have a true perianth and perfect flowers. Yet even those of comparatively high floral organization (such as *Castlenavia*, *Devillea* and *Terniola*, perfectly imitate Hepaticeæ in their vegetation; and *Tristicha hypnoides* might readily be mistaken by a casual observer for a true Moss.) The thirteen plates, some of them colored, and all crowded with exquisite analyses, are of the very highest order, and illustrate most of the genera characterized. A. G.

4. *Seeman*, *Botany of the Voyage of H. M. S. Herald*, *&c.* Part 2, pp. 61–80, plates xiii–xx. The first part of this work already noticed, contained the botany of Western Arctic America. The present is occupied with the Flora of Panama: it comprises a brief historical notice, and a detailed introduction, giving an account of the geographical features of the country, its climate, and the general characteristics of its vegetation, with notices of the most remarkable or useful plants, those used for medicine, food, cordage, dyes, &c., being separately enumerated. It affords much interesting information respecting a country with which large numbers of our own people now have much to do. Then follows a few pages of the Flora itself, which is here carried only through some of the earlier families. We are glad to see that the plants of Fendler's Chagres collection are enumerated. A good map of the country is given, comprising the provinces of Bocas del Toro, Veraguas, Panama and Darien. A. G.

5. *Walpers*, *Annales Botanices Systematicæ*, tom. ii, pp. 1125, iii, fasc. 1–4, pp. 786, 8vo, 1851–52: Leipsic.—The former volume, published in 1848–9, gave the characters of all the species, as far as known to the compiler, which had appeared in the years 1846 and 1847. This goes over the same ground for the years 1848, 1849, and 1850, in systematic order, following the arrangement of DeCandolle. Nineteen hundred pages in very small type are required to give merely the characters of the species published in various works or scattered papers during three years, down as far as to the Grasses, in the midst of which the fourth fascicle of the third volume breaks off. This rapid increase shows how needful is such a compilation as the present. The work has cost great labor; and even the few who have access to full botanical libraries will be thankful for it, although the pages abound with errors of the press, and slips or less venial mistakes of the transcriber. The *Genera Am. Bor. Or. Illustrata*, vol. i, is everywhere cited, up to page 660, as *Torr. Gen. Pl. Amer. Bor.* (The second volume, although published early in 1849, does not appear to have been seen by Walpers.) On the other hand, articles or species plainly published by Dr. Engelmann, under his own name, are attributed to Dr. Gray, as, for instance, the Portulaceæ on p. 660, et. seq., and the Cacteæ on p. 680, 684, and 686. A. G.

6. *Stansbury's Expedition to the Great Salt Lake.*—We have briefly noticed this very valuable Report in volume xiv, at page 291; and on

pages 126–129 of this number have cited from Mr. Hall's Report on the Geological Specimens. The Zoological and Botanical Reports connected with the volume contribute very largely to the value of the work. The Reports on Mammals and Birds are by Prof. S. F. Baird; that on Reptiles by Prof. Baird and Charles Girard; that on Insects by Prof. S. S. Haldeman; and that on Botany by Dr. John Torrey.

The Report on Mammals includes, besides notes on the known species, Putorius vison, P. erminea, Meles labradoria, Gulo luscus, Fiber zibethicus, Spermophilus 13-lineatus, and Ovis montana, a description of the new species *Vulpes macrourus*, Baird, and *Pseudostoma castanops*, Baird. The first is from the Salt Lake Valley. It resembles the *Vulpes fulvus*, but besides other differences, its tail is six inches longer. Color of the back, a mixed grizzled gray, the hairs being dark brown at the base, then yellowish-white, and finally tipped with black. The Pseudostoma is from the Prairie road to Bent's Fort, where it was collected by Lieut. Abert. It is in size between P. borealis and P. bursarius; the color is grizzled but lighter than in the P. bursarius; and there is a strongly marked chestnut circular space about 1¾ in. in diameter on each side of the head.

The Report on Birds contains the new species *Sialia macroptera*, from the neighborhood of the Salt Lake, and the *Pipilo Alberti*, from New Mexico, and notices of many known species. A list is added containing the names of over 150 species of birds from west of the Mississippi, which are not described in Audubon's Ornithology.

Among the Reptiles, there are the following new species, the most of which are illustrated with excellent figures. We cite the brief specific descriptions.

Siredon lichenoides, Baird.—Body uniform blackish brown, covered all over with licheniform patches of grayish yellow; snout rounded; tail compressed and lanceolated; toes broad and short.

Cnemidophorus tigris, Baird and Girard.—Scales on the subguttural fold small in size; four yellowish indistinct stripes along the dorsal region.

Crotaphytus Wislizenii, Baird and Girard.—Head proportionally narrow and elongated. Cephalic plates and scales on the back very small. Yellowish brown, spotted all over with small patches of deeper brown or black.

Genus Holbrookia, Girard, (syn. Cophosaurus, Trosch.)

Holbrookia maculata, Girard.—Tail about the length of the trunk. Head subcircular, slightly conical in front. Pectoral fold bordered with large scales.

Genus Uta, Baird and Girard.—Upper part of the body covered with minute scales; a pectoral fold; auditory apertures; femoral pores, but no anal ones.

Uta Stansburiana, Baird and Girard.—Tail slender, elongated, and conical, provided with large scales arranged in verticils; a subgular fold in addition to the pectoral one.

Sceloporus graciosus, B. and G.—Head subconical; scales of the back proportionally large; tail of medium size, slender and conical

Elgaria scincicauda, B. and G.—Dusky green above; light ash color below. Eleven transverse black bands on the back, interrupted on the dorsal line; white dotted posteriorly, six or more on the tail. Thirteen to fourteen rows of scales, well carinated.

Plestiodon Skiltonianum, B. and G.—Head small, continuous with the body; tail stout, very long, and subquadrangular; olivaceous brown, with four broad bands of black.

Genus Churchillia, B. and G.—Three pairs of frontal plates; a very small loral, and several postorbitals. Scales carinated.

Churchillia bellona, B. and G.—Body yellowish, with a series of large subhexagonal patches of brown bordered with black, and two or three rows of smaller patches on the sides. A brownish black band across the eyes, from top of head to the angle of the mouth.

Coluber mormon, B. and G.—Posterior frontal plates very large; vertical plate long and very narrow on its middle; eyes very large.

Heterodon nasicus, B. and G.—Minute and numerous frontal plates instead of two large pairs; two brown stripes over the head; temporal patch very broad.

A "monographic essay on the genus Phrynosoma," by C. Girard, next follows, beautifully illustrated, and containing the new species *P. platyrhinos*, G., *P. modestum*, G.

Prof. Haldeman's Report on Insects, contains descriptions of 25 new species, and is illustrated by two plates representing 13 species.

Dr. Torrey's Report is illustrated by nine plates, representing as many species.

7. *A New Genus and Species of Crustacea;* by JAMES EIGHTS.—This Antarctic species from the New South Shetlands, belongs to the Idotæa family. It is remarkable for its gigantic size, the length being 3¼ inches and the breadth across the middle 1¾ inches. It is also peculiar in having the 6 anterior legs short and monodactyle or ancoral, while the 8 posterior are long, stout, triangulate, spinose, and end in a short claw. Superior antennæ short, half the inferior in length, having a very short flagellum; inferior pair with a multiarticulate flagellum as long as the basal portion. Form of body oblong ovate. Abdomen 5-jointed, the last segment subtriangular with sinuato-arcuate sides, and subcarinate longitudinally along the middle above. Thorax also somewhat carinate along the middle of the back, and surface of segments sculptured: mandibles without palpi. The species is named by Dr. Eights, *Glyptonotus antarcticus.* The paper is accompanied by two handsome plates, representing a dorsal and ventral view of this fine species, and giving a separate view of the antennæ.—*Trans. Albany Inst.*

V. ASTRONOMY.

1. *New Planet;* (Astron. Jour., No. 50.)—On the 19th of September, 1852, another planet, (the *twentieth* of the Asteroidal group,) was discovered by Prof. A. de Gasparis of Naples. It resembled a star of the ninth magnitude, and its place was, Sept. 19, $10^{h.}\ 20^{m.}\ 24^{s.}$ m. t. Naples, R. A. $0^{h.}\ 12^{m.}\ 10^{s}.73$, and N. Decl. $1°\ 53'\ 0''.6$. The same planet was discovered independently the next day, by M. Chacornac of Marseilles.

2. *Return of the Twin-Comet of Biela*, (Astron. Jour., No. 49.)—The comet discovered Aug. 26, 1852, by Prof. Secchi of Rome, proves to be a portion of the twin-comet of Biela on its expected return. In a letter to Dr. Petersen, dated Rome, Sept. 16, 1852, he says, "I have the pleasure of announcing to you that I found this morning the other portion of Biela's comet. It was very faint, without a nucleus, and of an elongated ovoid form, the apex being turned away from the sun. It followed the other part at a distance of about two minutes of time, and was about half a degree farther south. The extreme faintness of this second portion, and my fear of losing the observation of the other did not permit me to make a better observation. * * * The principal part of the comet did not continue to appear of the same figure as at first. It looked quite irregular and had two very faint streaks: it was more luminous in the centre, but without any nucleus."

3. *Shooting Stars of August* 9–10, 1852.—Lieut. E. DE JONQUIÈRES, of the ship *Ville de Paris*, states (in a letter to M. Arago, printed in the *Comptes Rendus*, Sept. 13, 1852,) that on the 9th and 10th August, 1852, he was near Cagliari, Sardinia, and observed under favorable circumstances the shooting-stars which appeared at that time. The sky was clear, and the meteors were very numerous from the end of twilight. Between midnight and 4 A. M. of the 10th, the number (seen by one observer?) was about sixty-six per hour. The divergence of the meteors was quite constant from a point having a right ascension of $2^h\ 20^m$ and north declination of sixty degrees.

The next evening, (10th) the meteors appeared less abundant, but after a short time the sky became overcast, and farther observation was impossible.

VI. MISCELLANEOUS INTELLIGENCE.

1. *Meeting of German Naturalists at Wiesbaden;* (Ath., 1852, No. 1301.)—This Society, the prototype of our British Association, has just held its twenty-ninth annual meeting in the flourishing little town of Nassau; which was well calculated, as well from the extent of its public buildings and their adaptation to scientific *réunions* and social purposes, as also from the geological interest and natural beauties of the surrounding country, for the accommodation and entertainment of so numerous a body of scientific strangers. A correspondent, who was present, has furnished us with a summary,—which, as following close on the account of our own British meeting, will probably have an interest for our scientific readers.

On the 17th of September the members began to pour into the town from all quarters of Germany; each railway train bringing its own quota of these welcome visitors, in honor of whose approach the hotels and many of the public buildings and private houses were decked out with the national flag waving from the doorways and roofs.

To be a privileged member of this Association, with the right of speaking and voting in the meetings, it is necessary to have written some work bearing on natural history, physics, or medicine; but to become a temporary associate, with the right of being present as a listener merely at all the scientific meetings, as well as of taking part in all the festive social *réunions*, is free to every one on the very moderate payment of two Prussian dollars,—equivalent to scarcely six shillings of our money. Hence, when the annual meeting takes place in a town like this, numbers of the middle and upper classes of inhabitants eagerly join it, as well as all scientific strangers who may happen to be in the neighborhood. The objects of the society, like those of the British Association, are, the formation of a mutual acquaintance between the scientific men of Germany,—and the facilitation of an early interchange of their ideas in reference to all new discoveries. The numbers who this year took part in the matter amounted nearly to 800. Of the Germans present there were considerably more than a hundred names honorably known in the records of science,—and among the foremost may be named the octogenarian, Von Buch, Prof. Rose, the great analytic chemist, Von Carnall, Inspector of Mines, from Berlin, Prof. Haidinger, Director of the Imperial Geological Institute, Von Hauer, Von Ettingshausen, and Prof. Jäger, from Vienna, Von Leonhard and Chelius from Heidelberg, Nees von Esenbeck, the great systematic botanist, from Breslau, Gerlach, Will, and Heyfelder, from Erlangen, Wöhler, Baum, Lücke, and Weber, from Göttingen, Texter, from Würzburg, Hohl and Blazius of Halle, Forchhammer and Himly of Kiel, Seyfer of Stuttgart, Fichte, Vierordt, and Schlossberger of Tübingen, Schimper of Schwitzingen, Schmaltz of Dresden, Bach of Boppard, Rau of Bern, Lomby of Iburg, Martin of Jena, Rossmässler of Leipsic, Lehmann of Hamburgh, Weber and Budge from Bonn, Nasse from Marburg, Leuckhart, Vogel, Hoffmann, Eckhard, and Dieffenbach of Giessen, Schrötter and Müller of Aix-la-Chapelle, Müller and the two Sandbergers of Wiesbaden, Schulz of Deidishem, Prof. Stannius, Möser of Mayence, Adelmann of Dorpat, Spörex from Petersburgh, Grüsinger from Cairo, Remak, the physiologist, and a host of other names of equal significancy.

England had about twenty representatives present: including the names of Hamilton, Scoresby, Austen, Morier, Hoffmann, Lee, Hooker, Waller, &c. France had about nine or ten: of whom the most conspicuous were, Lucien Bonaparte, the Prince of Canino, Count d'Isoard-Cauvenargues, Marchal, Rigaud, Joly of Toulouse, &c.

The names of two courageous ladies were on the list of the associates; and very many others, accompanied by their male friends, graced the side benches and galleries during the general meetings, and took their seats at the festive board on the occasions of the three public dinners.

The first general sitting took place on the morning of the 18th, in the great room of the Kursaal. The President, Dr. Fresenius of Wiesbaden, opened the proceedings by a brief address on the objects of the Society and the advantages offered by Wiesbaden for their promotion:—after which the Rules were read by Dr. Braun. A report was next made on the intended monument to the memory of Oken in Jena. Von Leonhard read a paper 'On the advantages derivable from a careful Examination of the Products and Refuse of the Smelting House in reference to Geological hypotheses,' and was followed by Dr. F. Sandberger with a Report of the Geological Society of the Middle Rhine, and by Dr. Spengler 'On the Efficacy of the Waters of Ems in Bronchitis, &c.' The business of the day closed with a paper by Dr. Guido Sandberger 'On the Study of Organic Remains.'

On Sunday the 19th a public excursion was made down the Rheingau,—the railway and steamboat being put at the disposition of the learned strangers gratuitously; and on two subsequent days *fêtes champêtres* were given in their honor by the towns-people, and by the Duke of Nassau, in the picturesque sites of the Nersberg and the Plattz, with a profusion of the far-famed Steinberger and other generous growths of the valley of the Rhine.

On Monday, Wednesday, and Thursday, Sectional Sittings were held from eight to one o'clock.

On Tuesday and Friday, as on the previous Saturday, General Meetings took place in the Kursaal; in one of which Prof. Haidinger gave an interesting account of the recently formed Imperial Geological Institute of Vienna, of which he is Director. One of the first objects of this Institute will be, the production of a series of gelogical maps of the Austrian dominions :—the whole of which gigantic undertaking may be completed, it is to be hoped, within thirty years,—beginning with Austria Proper, and proceeding gradually to the Italian, Hungarian, and Bohemian dominions. In the promotion of this plan, the Professor ascribed much credit to the exertions of his countrymen and associates, Von Hauer, Von Ettingshausen, &c.

Prof. Nees von Esenbeck, of Breslau, delivered an Address in honor of the 200th anniversary of the Leopold-Caroline Academy of Science, consisting of a brief account of its origin and labors ; and was followed with a clever paper by Dr. Posner 'On the Influence which the Medical Profession ought to exercise on the Sanitary condition of their Fellow Men,'—a point on which the future welfare of the human race so mainly turns.

At the Third General Meeting (Friday) papers were read by Prof. Nees 'On the Responsibilities of the State in regard to Epidemics,'—which will be published in the Reports ; by Herr Voltz 'On the Tertiary Basin of Mayence ;' and by Dr. Rossmässler 'On the Importance of multiplying Associations for Scientific Objects.'

For the Meeting of the following year, the university town of Tübingen was fixed on.

In the Sectional Meetings the original communications and discussions were so numerous, that we must limit ourselves to a partial mention of them.

In the Physical Section, Prof. Müller presented 'A Table of General Formulæ for Crystallography.' Prof. Magnus 'On the Deviation of Projectiles.' Prof. Langsdorf 'On the Conducting Power of Silver.' Prof. Müller showed an Apparatus for displaying the Evolution of Caloric on the freezing of Water, and elucidating the formation of Hail, &c.'

In the Chemical Section,—Prof. Von Heinz 'On Animal Fats.' Prof. Seybel 'On the Progress of Chemical Manufactories in Austria.' Prof. Schödler 'On the Carbonization of Wood under Water.' Prof. Hoffmann 'On the Employment of Gas-burners in the Elementary Analysis of Organic Substances, &c.'

In the Geological Section, Prof. Zimmermann 'On very Recent Formations of Sulphur.' Prof. F. Sandberger 'On the Geology of Nassau.' Prof. Kurr 'On Fossil Human Teeth'—considered, however, by Prof. von Meyer to be, like other human fossil bones, probably post-diluvial. Prof. Klipstein 'On the Geological Formation of Hessia.' Prof. Austen 'On the Valley of the British Channel and Accumulations within it.' Prof. Dumont 'Comparison of the Geological Formations of England and Belgium.' Prof. von Hauer 'On the Tertiary Formation of the Basin of Vienna.' Prof. Schwarzenberg 'On the Geology of Algiers, &c.' Prof. von Ettingshausen 'On Filices, &c. in Coal Formation of Stradonitz near Beraun.' Prof. Desor 'On Parallel Phenomena produced by Diluvia and Glaciers in Scandinavia, Switzerland and North America.' Prof. Braun 'On Fossil Grapes at Salzhausen.' Prof. von Meyer and Prof. Thiollière 'On Vertebrata' in the newly-discovered lithographic Slate of Cerin, in France. Prof. Forchhammer 'Proposed Formation of a Sub-marine Chart of the Mediterranean.' Prof. Lesquereur 'Formation of Turf, &c.'

In the Botanical Section, Prof. Hoffmann 'On the Influence of River Boundaries on the Distribution of Plants.' Prof. Schimper 'On the Proposed Spirological Arrangement of Plants.' Prof. Fresenius 'On the Fungus of the Grape Disease.' Prof. Lehmann 'On the Development of Heat by the *Victoria Regina.*' Prof. Schucht 'On the Multiplication of Orchideæ by Bulbs.' Prof. Wirtgen 'On the Genus Mentha.' Prof. Hoffmann 'On the Red Fungus on the Potato in Westphalia.' Prof. Schenk 'On the Cultivation of the Silk-worm in Nassau.' Prof. Löhr 'On the Occurrence of South German Plants in the North, and *vice versâ.*' Prof. Seemann 'On the Fatty Substance obtained from the Euphorbiaceous Plant, *Stillingia sebifera*, very largely used for Stearine Candles in England.' Prof. Brandis 'On Atmospheric Showers of small black round Fungus (*Sclerotium semen*) near Cologne.'

Zoology,—Prof. Lee 'On the Dependence in Mammalia of the Spinal Cord on the Brain.' Prof. Vierordt 'On the Facilitating of the Counting of Blood-globules.' Prof. Stilling 'On the Microscopic Structure of the Central Nervous Organs.' Prof. Gerlach 'On the Cutaneous Papillæ and newly-discovered Special Pyramidal Organs of Touch,' contrary to Wagner, he discovers vascular ramifications in all of them. Prof. Hering 'On the Period of the Circulation'—above half a minute in the horse, not accelerated with respiration or beat of the heart. Prof. Budge 'Influence on the Pupil of the Frog of the Section of the Anterior and Posterior Spinal Roots.' Prof. Moleschott 'Diminution of Carbonic Acid in Respired Air, and of Red Globules in Blood, on removal of the Liver and Spleen in Frogs,'—and 'On the Formation of Sugar in Animals dependent on the Liver.' Prof. Will 'On the Hair of Caterpillars'—being tubes containing formic acid. Prof. Remak 'Fœtal Development of Vertebrata,'—the flat germ of birds consists of three layers, sensorial, motory and glandular and intestinal. Prof. Schiff 'Atrophy of Bone from Section of Nerves.' Prof. Meyer 'On the Microscopical Structure of the Nervous Fibres and Ganglia, and on the shortening of the Nerves in the Leech by a Muscular Sheath.' Prof. Waller 'On the Functions of the Ganglia and Spinal Marrow, as investigated by the Section of Spinal Roots.' Prof. Schlossberger 'On the Chemical Constitution of the Brain in different Animals and Ages.' Lucien Bonaparte 'On some New Species and Arrangement of Birds.' Prof. Rossmässler 'On the Necessity of an Anatomical Investigation of the Conchyliæ.' Prof. Calwer 'On the Development of the Buccinum Matatum;' wherein several ova go to the formation of one individual, whilst from the egg of the Tubularia, on the contrary, as shown by Beneden, several embryos come from one ovum. Prof. Joly 'On the real External Source of the Blue and Red Coloration of the Cocoon of the Silk-worm.'

Medical Section,—Prof. Rau 'Gutta Percha Ear-tubes and Probes.' Prof. Greisinger 'Typhus in Egypt'—characterized by bilious symptoms and by enlargement of spleen. Prof. Höfle 'On Microscopic Fungus occurring in Mucous Exudations.' Prof. Naumann 'On Exophthalmos in connexion with Enlargements of Thyroid and Heart.' Prof. Snell 'Loss of Cutaneous Sensibility, frequent in the mentally deranged;'—18 cases of entire loss, 160 of partial. Prof. Erlenmeyer 'On Derangements in the Sense of Touch, and their Relation to Mental Disease.'

2. *Stereoscope.*—A simple form of this ingenious instrument of Wheatstone is represented in fig. 1, on the next page. It is a variety of the instrument suggested by Brewster. In its cheapest style, it is made of Japanned sheet tin. The one here figured was 6 inches in length; the upright back measured 6 inches long by 3½ high; and the front 4½ inches long by 1⅞ high; the distance between the centres of the eye-holes 2½ inches. Below at middle is a handle for holding it. The two pictures to be viewed (one drawn as the object would appear a short distance off to the left eye, the other, as to the right eye, and the two on one piece of paper, the requisite distance apart) are placed against the back piece *bc*. On looking through the eye-pieces, the two pictures are superimposed at the middle point between them, and are seen as one; the several objects appear at their proper distances, in advance of one another; moreover every part stands out in bold relief, heads looking like stationary, etc. This superposition of the two pictures, which is due to a slight bending of the rays of light, may be produced by different kinds of eye-pieces. The following are among those that are suggested by Brewster. (1.) Two half-lenses (made by dividing a lens along a diameter), one for each eye-hole. The eye-aperture is circular, and the centre of the two apertures should pass through corresponding points of the semilenses, that is, be at equal distances from corresponding margins. The distance between the centres of the eye-pieces should equal the distance between the centres of the pupils of the eyes. They may be made so as to admit of adjustment for different eyes. This kind of instrument is called the *lenticular stereoscope*.

(2.) In a second kind, (the *prismatic stereoscope*,) a prism with a small angle is used (fig. 2) in the same manner essentially as the semilenses. A piece of window glass ground down on one side, or two thin plates of glass placed together at a small angle, with a drop of water between, will answer the purpose.

(3.) In a third *kind*, (the *reflecting stereoscope*,) the rays of light are bent by reflection from plates of black glass; common glass covered on one side with black sealing wax will answer. Two varieties are here figured from Brewster. In figure 4 the pictures (A, B,) have the reverse position they have in figure 3, owing to the reflection being reversed. The second is the more compact kind, and may be easily arranged in a tube. Even a single piece of glass, like the left one of either of these figures, is all that is necessary, the eye seeing the other picture direct and the angle of reflection being such as to superimpose the two in this mode of viewing them. The reflecting stereoscope is most easily adapted to eyes of different focal distanees, and also to pictures of different sizes. The semilenses have the advantage of magnifying the pictures.

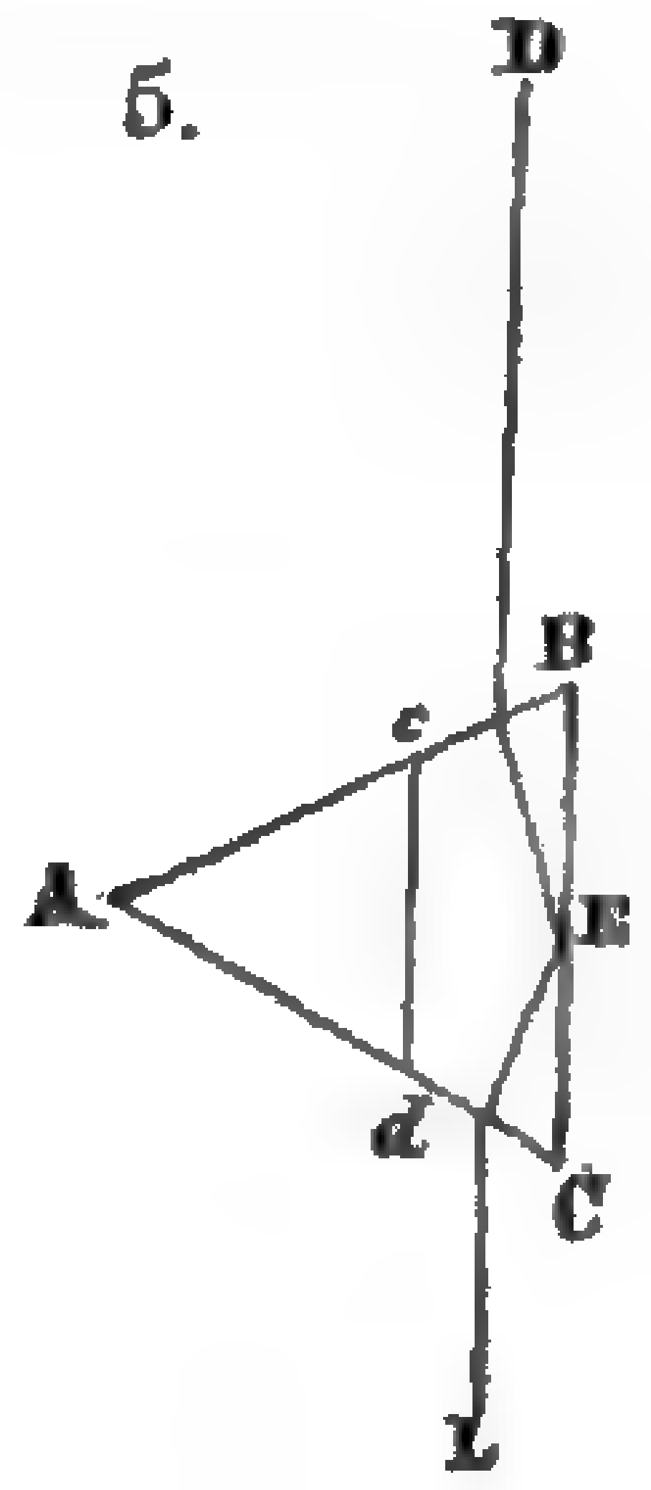
(4.) Another of Brewster's stereoscopes is the *Total Reflexion Stereoscope.* The left eye looks through a prism (fig. 5) from L, and sees one of the pictures at D, the ray refracted in the prism being totally reflected at E, while the other picture is seen direct with the other eye. The slight difference in the distance of the eyes from the superimposed pictures produces no appreciable injury to the effect. It is essential that the angles of the prism ABC and ACB should be equal. If the surfaces AB and AC are made convex by annexing to each a plano-convex lens, this kind of stereoscope then magnifies the objects seen.

In the above we have given only the simpler forms of the stereoscope for the sake of illustrating the principle on which it is constructed. They are forms that might be made without the aid of an optician.

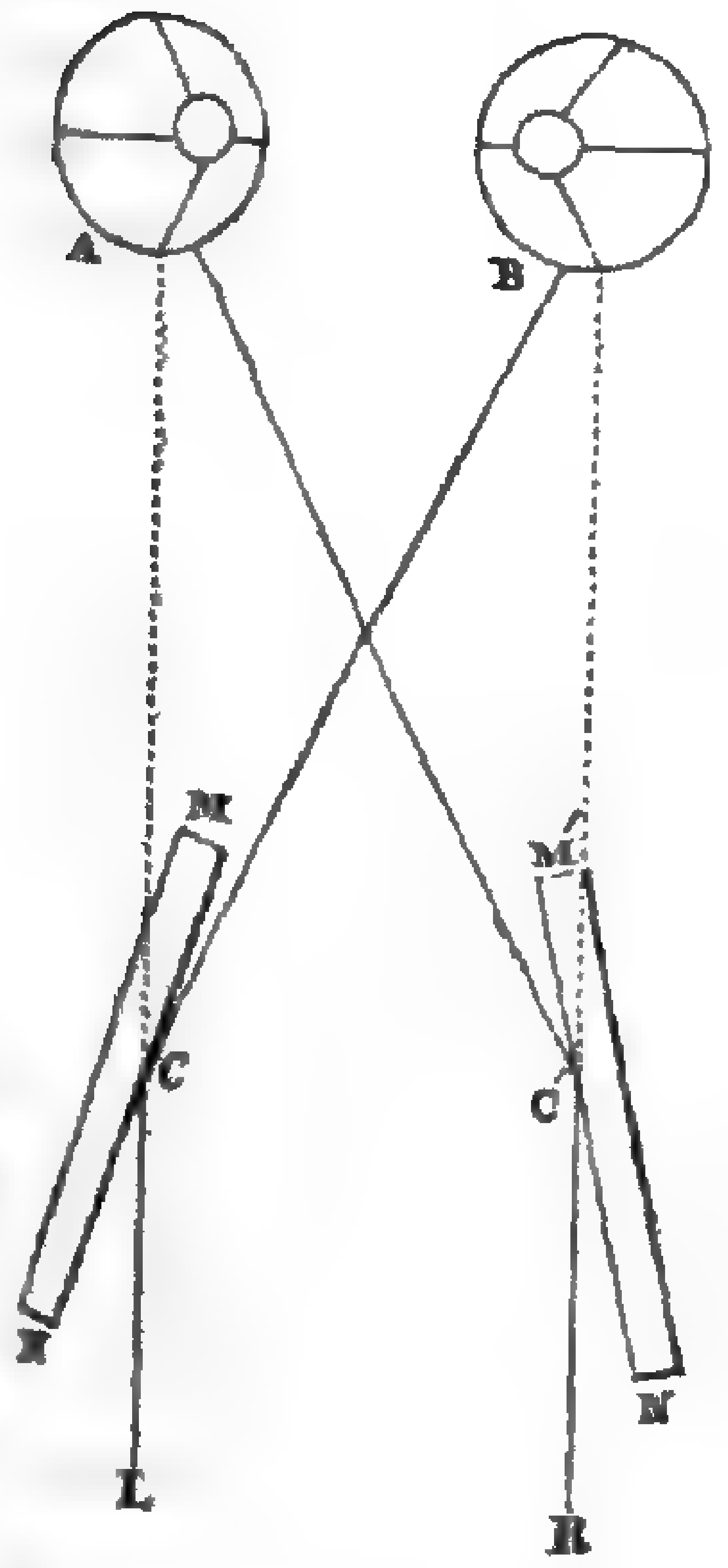
1.

2.

5.



3.



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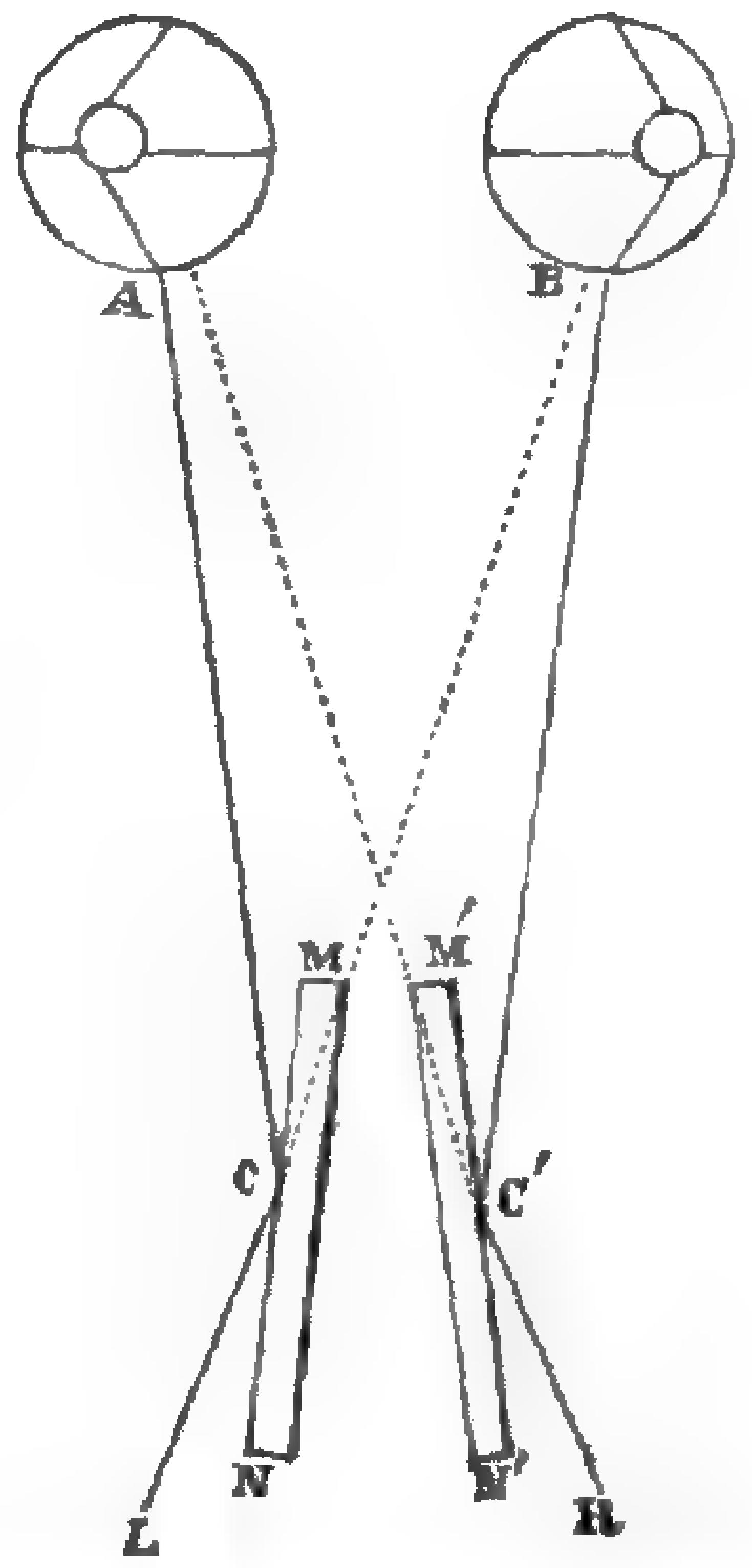
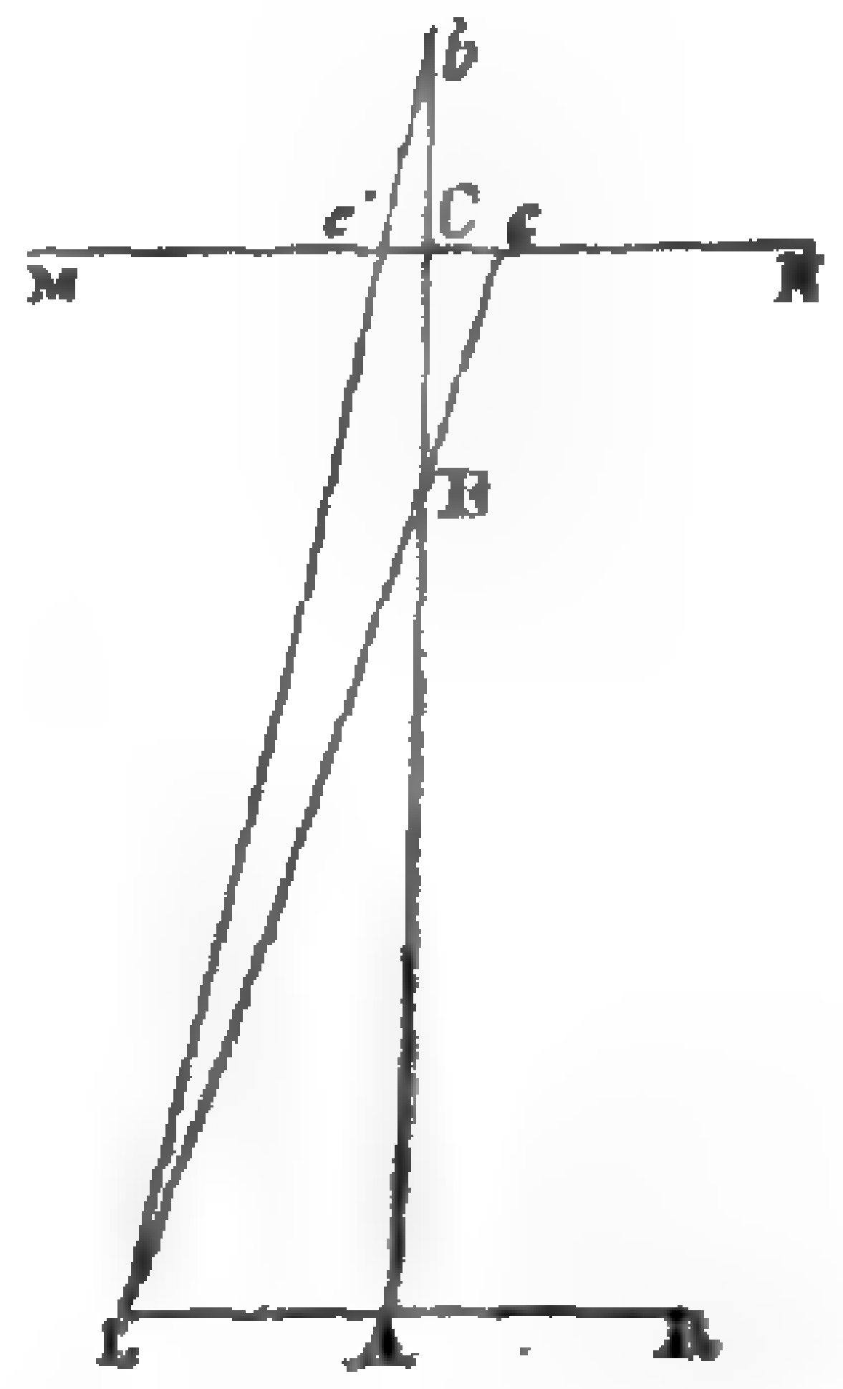


6.



To determine the required distance between the pictures, look at one picture with one eye-piece, and after obtaining the distance off for the best view, note how far the picture is displaced laterally by refraction, and then make the distance between the pictures or corresponding parts in the pictures, equal to twice this amount of displacement. In figure 3, the instrument would show a raised cone: but if B and A are transposed, it would give a hollow cone; or by using three figures, placing another B (which we may designate B′) to the left of A, the hollow and raised cone may be seen, alternately, according as B′ or B is superimposed on A. The small circle at the centre of each figure, although alike in all three, would *appear* larger in the raised cone than in the hollow cone, since in the former it would *seem* to be nearer the eye—an exact illustration, as Brewster states, of the difference between the apparent size of the moon near the horizon and at considerable altitudes.

Brewster also describes a binocular camera for making the pairs of drawings of any objects however large, and even of scenery, which are required for exhibition in the stereoscope. The difference in the two views will be at once apprehended on shutting first one eye and then the other, and observing the difference in the relative parts of an object thus seen, arising from the distance between the eyes. To obtain pictures of the two kinds of the requisite nicety for use in the stereoscope, photography or a binocular camera is required.

A camera with several adjustments for producing stereoscopic pictures was described at the recent meeting of the British Association by Mr. A. Claudet (see page 124).

Brewster gives the following directions for drawing on a plane the dissimilar representations of solids for the stereoscope (Phil. Mag. [4], iii, 16):

Let L, R, fig. 6, be the left and right eye, and A the middle point between them. Let MN be the plane on which an object or solid, whose height is CB, is to be drawn. Through B draw LB, meeting MN in *c;* then if the object is a solid, with its apex at B, C*c* will be the distance of its apex from the center C of its base, as seen by the left eye. As seen by the right eye R, C*c′* will have the same value, but *c′* will lie on the left side of C. Calling E the distance between the two eyes, and *h* the height BC of the solid, we shall have $\mathrm{AB} : h = \frac{\mathrm{E}}{2} : \mathrm{C}c$ and $\mathrm{C}c = \frac{h\mathrm{E}}{2\mathrm{AB}}$, which will give us the results in the following table, AC being $=8$ and $\mathrm{E}=2\frac{1}{2}$ inches:—

Height. BC=*h*.	AB.	C*c*.	Height. BC=*h*.	AB.	C*c*.
1	7	0·279 inch.	5	3	2·088 inch.
2	6	0·4166 "	6	2	3·75 "
3	5	0·75 "	7	1	8·75 "
4	4	1·25 "	8	0	Infinite.

If we now wish, by directing the axes of the eyes beyond MN to *b*, to ascertain the value of C*c′*, which will give different depths *d* of the *hollow* solids corresponding to different values of C*b*, we shall have $\mathrm{A}b : \frac{\mathrm{E}}{2} = d : \mathrm{C}c'$ and $\mathrm{C}c' = \frac{d\mathrm{E}}{2\mathrm{AB}}$; which, making AC8 inches as before, will give the following results:—

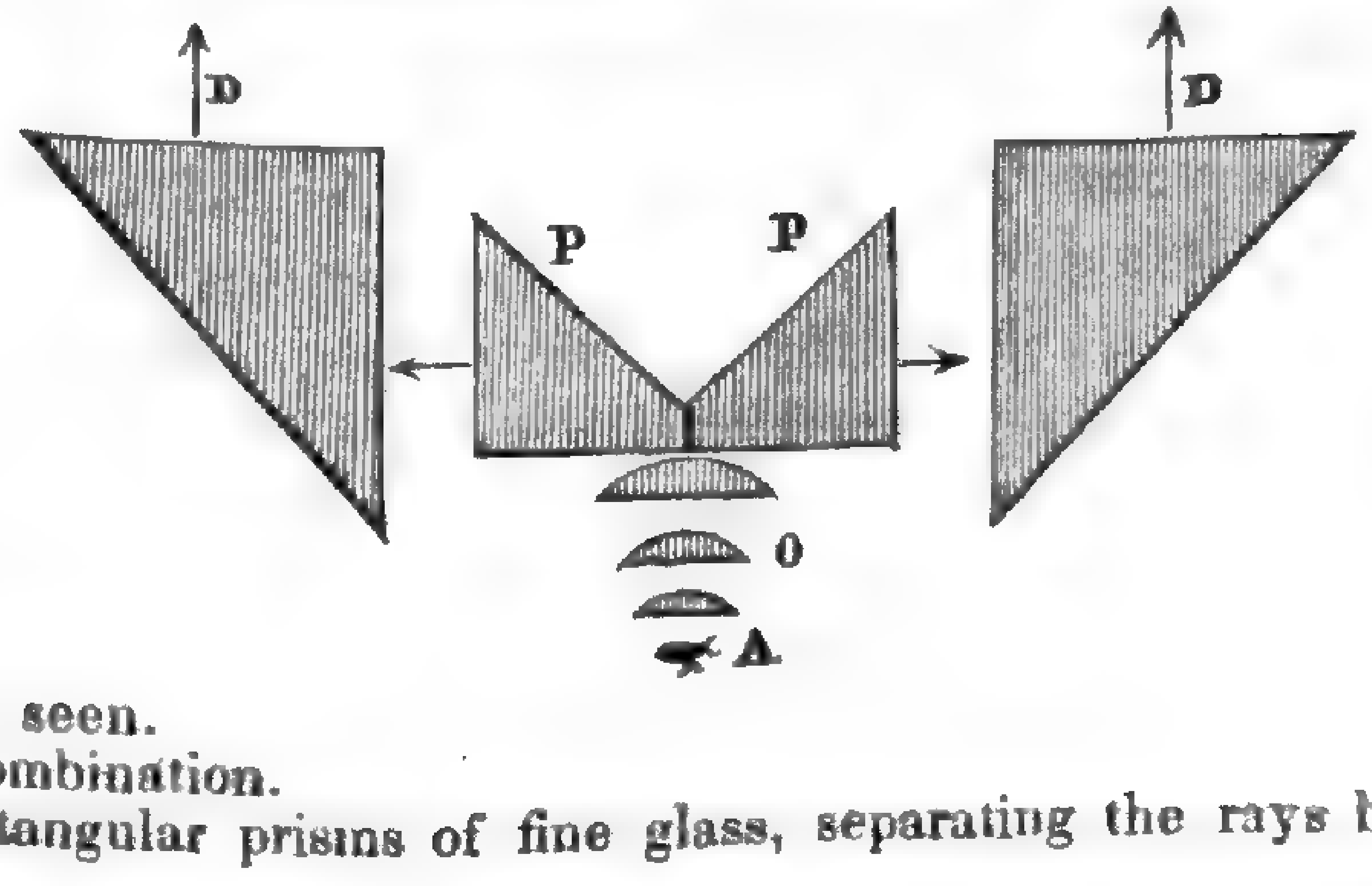
Depth. C*b*=*d*.	A*b*.	C*c′*.	Depth. C*b*=*d*.	A*b*.	C*c′*.
1	9	0·139 inch.	7	15	0·58 inch.
2	10	0·25 "	8	16	0·625 "
3	11	0·34 "	9	17	0·663 "
4	12	0·4166 "	10	18	0·696 "
5	13	0·48 "	11	19	0·723 "
6	14	0·535 "	12	20	0·75 "

The values of *h* and *d*, when the excentricities C*c*, C*c′*, as we may call them, are known, will be found by the formulæ $h = \frac{\mathrm{C}c\mathrm{E}}{2\mathrm{AB}}$ and $d = \frac{\mathrm{C}c'\mathrm{E}}{2\mathrm{AB}}$. As C*c* is always equal to C*c′* in each pair of figures or dissimilar pictures, the depth of the *hollow* solid will always appear much greater than the height of the *raised* solid one. When C*c* and C*c′* are both 0·75 $h : d = 3 : 12$, and when they are both 0·4166, $h : d = 2 : 4$, and when they are both 0·139 $h : d = 0{\cdot}8 : 1{\cdot}0$.

3. *Pseudoscope of Wheatstone,* (Phil. Mag. [4] iii, 151.)—As this instrument conveys to the mind false perceptions of all external objects, the author calls it a Pseudoscope. It consists of two reflecting prisms,

placed in a frame, with adjustments, so that, when applied to the eyes, each eye may separately see the reflected image of the projection which usually falls on that eye. This is not the case when the reflection of an object is seen in a mirror; for then, not only are the projections separately reflected, but they are also transposed from one eye to the other, and therefore the conversion of relief does not take place. The pseudoscope being directed to an object, and adjusted so that the object shall appear of its proper size and at its usual distance, the distances of all other objects are inverted; all nearer objects appear more distant, and all more distant objects nearer. The conversion of relief of an object consists in the transposition of the distances of the points which compose it. With the pseudoscope we have a glance, as it were, into another visible world, in which external objects and our internal perceptions have no longer their habitual relations with each other. Among the remarkable illusions it occasions, the following were mentioned. The inside of a tea-cup appears a solid convex body; the effect is more striking if there are painted figures within the cup. A china vase, ornamented with colored flowers in relief, appears to be a vertical section of the interior of the vase, with painted hollow impressions of the flowers. A small terrestrial globe appears a concave hemisphere; when the globe is turned on its axis, the appearance and disappearance of different portions of the map on its concave surface has a very singular effect. A bust regarded in front becomes a deep hollow mask; when regarded *en profile*, the appearance is equally striking. A framed picture, hung against a wall, appears as if imbedded in a cavity made in the wall. An object placed before the wall of a room appears behind the wall, and as if an aperture of the proper dimensions had been made to allow it to be seen; if the object be illuminated by a candle, its shadow appears as far before the object as it actually is behind it.

4. *Riddell's Binocular Microscope.*—On page 68 Dr. Riddell has given a description of this important instrument. As figures, which we are expecting from him have not arrived, we copy the following from a letter of his, published in the Boston Traveller of Dec. 8.



A. Object to be seen.
O. Objective combination.
P P. Two rectangular prisms of fine glass, separating the rays by internal reflection, at 45°.
D D. Outer rectangular prisms, adjustable, for different distances between the eyes. These send each bundle of rays, in the direction denoted by the arrows, to be received by the oculars and erectors, also adjustable.
A O, P P, may be inverted, or turned half way round, so that the object will be above.

Dr. Riddell prefers to have the stage fixed, and the slow motion for adjusting the focus of the objective, made to affect the whole structure —O, PP, DD.

5. *On the Koh-i-noor Diamond;* by Prof. TENNANT, (Athenæum, No. 1300.)—At the last meeting of the British Association, Dr. Beke read a paper 'On the Diamond Slab supposed to have been cut from the Koh-i-noor.' He stated:—"At the capture of Coochan there was found among the jewels of the harem of Reeza Kooli Khan, the chief of that place, a large diamond slab, supposed to have been cut from one side of the Koh-i-noor, the great Indian diamond now in the possession of Her Majesty. It weighed about 130 carats, showed the marks of cutting on the flat and largest side, and appeared to correspond in size with the Koh-i-noor." Prof. Tennant was induced to record his opinion of the probability of this being correct. He had made models in fluor spar, and afterwards broken them, and obtained specimens which would correspond in cleavage, weight and size with the Koh-i-noor. By this means he was enabled to include the piece described by Dr. Beke, and probably the large Russian diamond, as forming altogether but portions of one large diamond. The diamond belongs to the tesseral crystalline system: it yields readily to cleavage in four directions, parallel to the planes of the regular octahedron. Two of the largest planes of the Koh-i-noor, when exhibited in the Crystal Palace, were cleavage planes,—one of them had not been polished. This proved the specimen to be not a third of the weight of the original crystal, which he believed to have been a rhombic dodecahedron; and if slightly elongated, which is a common form of the diamond, would agree with Tavernier's description of it as bearing some resemblance to an egg. Sir D. Brewster made some observations, and stated that the English translation of Tavernier's work left out the minute details which were fully given in the original. Sir David expressed his satisfaction with Mr. Tennant's illustration,—which clearly proved the diamond to be only a small part of a very large and fine stone.

6. *On Glynn and Appel's Patent Paper for the prevention of Piracy and Forgery by the Anastatic Process;* by S. BATESON, Esq., (Athenæum, No. 1300.)—As some may be unacquainted with the nature of the Anastatic process itself, and of the abuses of which it is capable in unscrupulous hands, I think it right, in the first place, to give you a short account of its history, nature, and progress. It was invented some eight or nine years ago by Mr. Rudolph Appel, a native of Silesia, who came over to this country. Owing to various circumstances, the Anastatic printing languished for several years, until tardy justice was done to its inventor at the Great Exhibition in 1851, when a prize medal was awarded him. Since that time it has been becoming more generally known. The term 'Anastatic' means rising up, or a reproducing as it were, and very significantly does the name express the result; for by it any number—thousands upon thousands—of reproductions of any printed document may be obtained, each of which is a perfect *fac-simile* of the original, no matter how elaborate the engraving may be, or how intricate the design.

I will now endeavor to describe the actual operation of Anastatic printing. The print of which an Anastatic copy is required is first moistened with very dilute nitric acid (one part of acid to seven of water), and then being placed between bibulous paper, all superabundance of moisture is removed. The acid being an aqueous solution, will not have attached itself to the ink on the paper, printers' ink being of an oily nature; and if the paper thus prepared be placed on a polished sheet of zinc and subjected to pressure, two results follow:—In the first place, the printed portion will leave a set-off or impression on the zinc; and secondly, the nitric acid attached to the non-printed parts of the paper will eat away and corrode the zinc, converting the whole, in fact, into a very shallow stereotype. The original being removed (perfectly uninjured), the whole zinc plate should next be smeared with gum-water, which will not stick to the printed or oily part, but will attach itself to every other portion of the plate. A charge of printers' ink being now applied, this in its turn only attaches itself to the set-off obtained from the print. The final process consists in pouring over the plate a solution of phosphorous acid, which etches or corrodes more deeply the non-printed portion of the zinc, and produces a surface to which printers' ink will not attach. The process is now complete, and from such a prepared zinc plate any number of impressions may be struck off.

The uses to which this invention may be applied are various. Copies of rare prints may be obtained without the aid of an engraver. Reproductions of books, or of works out of print, may be had without setting up the type; authors may illustrate their own works, and amateur artists may have fac-similes of pen-and-ink sketches at a very inconsiderable expense. To be in accordance with the facts already mentioned, the anastatic process should only be applicable to the copying of impressions made with printer's ink; any other inks, however, even the most fugitive, may be adapted to this operation, and hence, without some safeguard, the dishonest practices to which the anastatic process might be applied would be numerous. Copies of cheques and bank notes may be taken so as to defy scrutiny. In point of fact, bankers have been mistaken again and again when examining notes and cheques forged by this process; and as I have now endeavored to impress upon you the laws, I will shortly describe the antidote which is offered by the patent paper invented by Messrs. Glynn & Appel. It is as beautiful from its simplicity as it is efficacious in its operation. It consists merely in impregnating or dyeing the pulp of which the paper is made with an insoluble salt of copper. After a series of experiments, the patentees preferred phosphate of copper to any other salt; and for this purpose, sulphate of copper and phosphate of soda are successively mixed with the pulp, which, of course, produce an insoluble salt, the phosphate of copper. Besides this, a very small portion of a peculiar oily and non-drying soap is introduced, which affords a double protection. Should the forger attempt to submit a note or cheque printed on the patent paper to the anastatic process, a film of metallic copper separates between the paper and the zinc, not only preventing a set-off, but cements the paper so strongly that the paper must be destroyed—it can only be removed in small pieces. Thus, the forger is punished by the loss of the original, the public protected, and the banker benefitted, as it is presumed no forger would apply for the value of the note so unlawfully used. Hitherto, elaborate engraving, beauty of design, and execution by skillful hands have been the sources of protection, and under such conditions a forger must either be a skilful engraver, or employ some person to engrave for him. This fact has generally led to the detection of forgery; but you can easily imagine how justly alarmed bankers will become when they learn that any one who understands what is called chemical, that is to say, lithographic printing, may, with the aid of a zinc plate, a little nitric acid and a press, be able to produce such perfect fac-similes of notes and cheques as to pass the scrutiny of the most lynx-eyed of their clerks. You will agree with me that it would be wrong, if not criminal, to publish to the world so dangerous a process to facilitate forgery, unless I were, at the same time, to produce a safeguard which would absolutely defeat such attempts.

4. *Notice of the "Ice Spring" in the Rocky Mountains*, (from a letter of Geo. Gibbs, Esq.)—The Ice Spring, so called, is considered by the mountaineers as one of the curiosities of the great trail from the States to Oregon and California. It is situated in a low marshy "swale" to the right of the Sweetwater river, and about forty miles from the South Pass. The ground is filled with springs, and about eighteen inches beneath the turf, lies a smooth and horizontal sheet of ice, which remains the year round, protected by the soil and grass above it. At the time of our passing, July 12th, 1849, it was from two to four inches thick, but our guide told us that he had seen it a foot deep. It is perfectly clear, and beautifully disposed in hexagonal prisms, separating readily at the natural joints. The ice has a slightly saline taste, the ground about it, as with the Sweetwater and Platte river country generally, being impregnated with salts, and the water at one spot near by tasted of sulphur. Not the least singular circumstance was the smoothness of the upper surface of the stratum, although formed beneath the soil.

5. *Mollusca of the West Indies.*—Prof. C. B. Adams of Amherst College, Mass., who has been engaged in personal explorations of the West Indies, and has described a large number of its Mollusca, is desirous of obtaining further facts relating to the distribution of species, and invites the coöperation of any who are willing to aid him. He states that parcels may be forwarded to him through Robert Swift, Esq., of St. Thomas, W. I., J. H. Redfield, Esq., 16 South st. N. York City, or J. M. Murray & Co., Booksellers, 139 Atlantic st., Brooklyn. Specimens of doubtful locality would be of little value, and the locality should be minutely stated. In all cases when desired, he will return other shells in exchange, for which exchanges he is well furnished with species from all parts of the world.

6. *Earthquake in New England.*—On Saturday night, the 27th of November last, near midnight, an earthquake was felt at Salem, Beverly, Woburn, Groton and Wenham in Massachusetts, and also at Exeter in New Hampshire. The shock lasted about thirty seconds, and aroused the people from their slumbers, causing a sensible shaking of the houses, etc.

7. *Fossil Elephant.*—The Zanesville (Ohio) Courier reports the recent discovery of a fossil Elephant on the line of the Central Ohio railroad, on the river in the eastern part of Zanesville, in a tolerably good state of preservation. This is the third of the same species that has been discovered in this bank within a few years. One of the tusks

was sound, but broken off 8 feet from its base; its circumference at the lower end was 26½ inches, at the upper 16½. Two of the molars weigh 20 lbs. each, and two 14 lbs.

8. *Gold in Vermont;* by Prof. O. P. HUBBARD, (from a letter dated Hanover, N. H., Dec. 9, 1852.)—To-day, Mr. Kennedy of Plymouth, Vt., southwest of Woodstock, has brought me some specimens of gold found in *Bridgewater*, west of Woodstock, in spongy or mossy pieces, scales and knobs, which were all taken from the gangue; also in white quartz and in ferruginous quartz more or less covered with the red oxyd of iron, associated with galena and copper iron pyrites.

OBITUARY.

GIDEON ALGERNON MANTELL, LL.D., F.R.S., F.G.S., &c., died at his residence in Chester Square, London, November 10th, aged, we believe, about sixty-four.

Often, during our editorial career of thirty-four years, have we been called to the painful duty of recording the death of men, coadjutors with us in the cause of science, and of not a few with whom we have been connected by ties of personal friendship; but never have we been so painfully surprised, as by the recent announcement of the sudden death of the eminent and excellent man named above.

Thirty years ago, his splendid quarto of 320 pages, with 43 plates, devoted to the geology of Sussex, his native county in England, made its appearance. It was followed, at the end of five years, by a thinner quarto, equally a finished production, with 21 plates illustrative of the geology of the southeast of England, including Sussex and Tilgate forest. These original works, abounding with interesting and instructive observations, established the author's reputation throughout Europe as an able geologist, and as an acute and successful expositor.

The scene of his personal researches in geology, commencing at Lewes, his native town, extended from London and its vicinity to Brighton on the English channel, and from Dover to the Isle of Portland, including Hampshire and the Isle of Wight, and never was a geological field more faithfully or more successfully explored. Dr. Mantell made also occasional excursions into Wales and Derbyshire, to Oxford, Edinburgh, &c. The fossils of the chalk, and the colossal reptiles of the Wealden formation below the chalk, make a conspicuous figure in his works, among a multitude of other organic relics of early creations.

Dr. Mantell lived successively at Lewes, Brighton, Clapham and London, in all of which places he sustained an extensive professional practice, both in medicine and surgery, and still found time, in consequence of his great industry, to cultivate geology and the allied sciences, especially comparative anatomy, and to give many lectures on these subjects, in compliance with invitations from various towns and cities. As a lecturer, he was lucid, animated and eloquent; and having the advantage of a noble presence, with a voice of great power and of a fine musical cadence, his appearance was eminently attractive. He had a perfect command of the most appropriate language, and his chastened enthusiasm always carried his audience along with him. His well deserved celebrity insured on the part of the public a welcome reception to several important works, which, in the course of a few years, he wrote and published.

The Wonders of Geology, in 2 volumes, was an embodiment and enlargement of his lectures, and a more instructive and delightful work on that science has never been produced. It passed through several editions in England; and an American edition (printed in London) was published, prefaced by an introductory discourse intended to adapt the work more particularly to this country.

The *Medals of the Creation*, also in two volumes, contained a learned and instructive synopsis of the fossils of all ages, and was illustrated by numerous excellent figures.

The *Geology of the Isle of Wight*, in one volume, gave a full and faithful account of that beautiful and remarkable island, replete with fossils and containing in its lower strata, limbs, vertebræ and other bones of ancient reptiles more colossal than any that had been before discovered. This work also is fully illustrated.

Nearly the last of Dr. Mantell's great labors was a digested account of the fossils in the British Museum, with illustrations; it forms a thick volume, and is entitled *Petrifactions and their Teachings*. It is a very interesting and instructive guide through the British Museum, and is fitted to be a pioneer in palæontology generally.

Among his smaller works—the *History of a Pebble*—was a charming little book, adapted to the capacity of young people and even of children, while it was acceptable to the mature geologist; it passed through many editions.

Two thin quartos, amply illustrated (as usual with the author), one on the Fossils of Sussex, and the other on the Geology of Leith Hill, are gems in geology.

His *Days' Walk around Lewes*, is an excellent guide in that region, both in geology and archæology. On archæology as regards the proofs of the existence of man in different geological eras, he delivered an important lecture before the Archæological Society of Oxford University.

To the list of Dr. Mantell's works, we add a handsome quarto narrative of the visit of William IV. and of Queen Adelaide at the ancient borough of Lewes, with original poetry and portraits. Also Thoughts on Animalcules, and a splendid Pictorial Atlas of fossils, the illustrations chiefly selected.

Of his numerous memoirs, those on the fossil reptiles of the southeast of England—on the Belemnite and Belemnoteuthis—and on the Moa,* the extinct fossil bird of New Zealand, are among the most remarkable.

He was employed, near the close of his life, in revising the Medals of the Creation for a new edition, in which he was remodelling it so far as to make it almost a new work; but the delay in the printing caused him much uneasiness. The revision has been left by him in an unfinished state, and it is earnestly to be hoped that some scientific friend, equal to the undertaking, will resume the work and carry it through.

Dr. Mantell, a number of years ago, sustained a severe injury on the spine, in consequence of a fall from his carriage, and an incurable tumor arose, which by its pressure upon the nerves of the spinal chord,

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* His eldest son, Mr. Walter Mantell, living in New Zealand, obtained and sent to his father a large collection of the bones of the Moa.

produced at first temporary paralysis, and subsequently through life, frequent and intense neuralgic suffering, attended by great emaciation. Still his powerful and enthusiastic mind rose above his sufferings, although they often deprived him of sleep. He wrote several of his works while he was a martyr to pain; at the same time he continued his professional visits, and at the bed side of his patients, and when in society at home or abroad, he assumed a degree of cheerfulness which might have led any one to suppose that he was in perfect health. During the last week of his life he suffered intensely, and was deprived almost entirely of sleep; still, although observed to look unusually ill, he gave a public lecture, with his usual animation, two days before his exit, and visited his patients the very day before he died. He also continued to labor upon the Medals, until he retired to his chamber, on the night preceding his decease. He was then in great suffering; and at 3 o'clock P. M., of November 10, he passed gently away without a struggle, and probably was never conscious of his transition, until his spirit awoke in another world.

As a personal friend, Dr. Mantell was most interesting and estimable. His affections were warm, his intellectual perceptions acute, and his capacity for social enjoyment was so great, that the presence of a friend aroused his active mind even when suffering intense pain; his powers instantly rallied and poured forth treasures of knowledge and often literary and poetical effusions with a natural eloquence and finished grace which made him a most delightful companion. In affairs of business, he was ever exact and responsible, and as far as possible, left no pecuniary transactions to be finished by other hands.

He was an elegant artist; his off-hand pen or pencil sketches, occasionally enclosed in letters to his friends, were both elegant and effective, and most of his illustrations in his earlier works were drawn by himself. It is stated on the title-page of the Geology of Sussex, that the drawings were made by the author and the engravings were executed by Mrs. Mantell. This lady and three children survive.

Dr. Mantell's ancestors were distinguished in several of the arbitrary reigns of England, as friends of human liberty, and some of them paid the price of their blood.

Dr. Mantell was remarkable for his candor and kindness, and for scientific justice,* especially to original discoverers, whether eminent or humble, and no British philosopher excelled him in liberality and courtesy towards the scientific and literary productions of this country and their authors.

Although he sold to the British Museum some years since the greater part of his vast collection of fossils of the southeast of England, his private dwelling was still a rich museum of most interesting objects of nature and art:—every thing conspired in perfect unity, to one

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* Dr. Mantell transmitted to Baron Cuvier the then (1822) newly discovered teeth of the gigantic fossil reptile, since named the Iguanodon; and in the record of Cuvier's opinion quoted by Dr. Mantell in his Geology of Sussex and Fossils of Tilgate Forest, 1827, p. 71, are the following expressions, which prove that he gave to the illustrious Cuvier the credit which was his due:

"Ces dents me sont certainement inconnus—je crois qu'elles appartient—à l'ordre des reptiles—n'aurious nous pas ici un animal noveau, un reptile herbivore?"

effect, corresponding with the accurate science and elegant taste of the lamented proprietor. The rare combination of exact and thorough scientific knowledge with the enthusiasm of a discoverer and the rich but chastened diction of a poet, were never more remarkably united than in him. His letters were a rich feast to his friends. Full of information and thought, and the kindest feelings, and being punctual in responding to letters addressed to him, those who were so happy as to enjoy his confidence and correspondence always hailed with joy his beautiful and well known inscriptions.

Dr. Mantell's early training in religion was under pious parents, and his retentive memory enabled him when young to repeat a large part of the Bible by heart. This statement, which came to us from his own lips, is in accordance with a fact which illustrates the power of his memory, that, in conversation, he would often repeat with perfect facility and accuracy, whole pages of his favorite English classics, and with that finished and graceful intonation for which he was so remarkable.

B. S., SR.

Dr. DANIEL DRAKE.—Dr. Drake died in Cincinnati, his place of residence, Nov. 7, aged 67 years. We defer to another number a farther obituary of this distinguished man.

Dr. PFAFF, senior of the Professors of the Royal University of Kiel, has died within a few months past, at the age of 79.

VII. BIBLIOGRAPHY.

1. *First Principles of Chemistry ;* by B. SILLIMAN, JR., third edition, 555 pp. 12mo. Philadelphia, Loomis & Peck.—This work has been throughout revised and to a great extent re-written by the author, and it has thus been brought up to the present state of the science. Moreover the illustrations have been much increased in number.

The latter portion of the volume, embracing about 160 pp., is an introduction to Organic Chemistry, by Mr. T. Sterry Hunt, Chemist to the Geological Commission of Canada, and has been re-written by him for the present edition. The author is well known to our readers, by his various communications to the Journal of Science during the last six years, and we find many of his peculiar views embodied in the treatise before us. Although limited in its plan, and intended as a work for the young student, there are many points of interest and novelty which render the book not unworthy the notice of more advanced scholars.

The theory of chemical changes announced by Mr. Hunt, is very simple. The changes are reduced to two cases; direct union on the one hand, and direct division on the other: either of these may occur independently of the other, but they are very often united; the body formed by the first process is directly broken up by the second, and if the affinities which produced the union have been subverted, the results of the division are unlike the original factors, and we have the case of double decomposition, or equivalent substitution, in which process he supposes that direct union always forms an intermediate stage. This is illustrated by the case of olefiant gas $C_4 H_4$, which unites directly with Cl_2, to form the body $C_4 H_4 Cl_2$; this under certain conditions may break up into HCl, and C_4H_3Cl, these being products of substitution from C_4H_4, and from Cl_2; for these decompositions are always reciprocal, and C_4H_3 is *equivalent* to Cl and to H. The author insists that the notion of equivalents has been too much restricted by the definitions imposed at an early period of the science, and with Gerhardt considers fifty-eight parts of manganese in permanganic acid, to be as truly the equivalent of Cl and of H, as twenty-eight parts are in the protosalts, or eighteen and two-thirds parts, in the persalts of that metal. Organic is distinguished from inorganic chemistry, as being the chemistry of the carbon series, including all those bodies which evolve carbon in their ultimate chemical analysis. But even this distinction is arbitrary, and there are groups of homologous bodies which unite the two divisions. Hydrogen, in its equivalent of four volumes, and represented as H_2, is regarded as a type of all the hydrocarbons, and the homologue of such as are represented by $(C_2H_2)nH_2$; while hydrochloric acid, HCl, the metals, M_2, and the hydrid of copper of Wurtz, Cu_2H, or CuH, in which *cuprosum*, or copper in twice its ordinary equivalent, replaces H, are species of the same type.

Water, represented as H_2O_2, and equal to four volumes of vapor, is in the same way bibasic, being the prototype of oxyds, hydroxyds, and sulphids, and the functional homologue of the alcohols, and ethers of the formula, $(C_2H_2)n$, H_2O_2. All the other ethers are homologous with their parent acids. These important relations, since recognized by Gerhardt and Laurent, were first pointed out by the author, in the pages of this Journal.*

The peroxyds like Ba_2O_4, and the corresponding sulphids, are not regarded as bodies in which the metal unites in a less equivalent than in the protoxyds, but, from analogy with the higher sulphuretted ethers, as protoxyds and protosulphids, which have directly fixed O_2 and S_2, without change of volume.

While he rejects the terminology of the compound-radical theory, the author maintains the principle insisted upon by Liebig that the ethers are analogous to salts, and that a group like $(C_2H_2)nH$, equivalent to H, may be substituted in acids, for the hydrogen replaceable by a metal, thus explaining the loss of basicity, which the hypothesis of Gerhardt leaves unaccounted for. This question has been treated at length by the author in this Journal.†

In describing the cyanic compounds, he suggests that oxygen may be looked upon as replacing carbon in many bodies, without any change of type. C_2H_2, and C_2HN, are thus assimilated to water O_2H_2, while cyanogen, C_4N_2, corresponds to peroxyd of hydrogen, O_4H_2, and thus the fixing of the cyanic elements, is to be compared to the combination of water. In the case of the hydrocyanic ethers, the substitution of C_2HN for the O_2H_2 of any alcohol, enables us to add C_2 to the group, and thus to rise to the acid of an alcohol higher in the organic scale.

The polycyanids, whose equivalent he finds in the liquid obtained by Bouis in acting with chlorine, aided by sunlight, upon a hot saturated solution of cyanid of mercuy, and having the formula $C_{12}N_4Cl_{14}$,

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* March, 1848, p. 265, and July, 1849, p. 91, et seq.
† May, 1849, p. 399, and July, 1849, p. 89.

contain generally six equivalents of hydrogen or a metal; the ferrocyanids being $C_{12}\,Fe_2\,M_4\,N_6$, and the ferricyanids, containing iron in two-thirds its ordinary equivalent, $C_{12}\,Fe_3\,M_3\,N_6$. These two salts are respectively quadri- and tribasic, but in the nitroprussids the first form has lost H_2 becoming bibasic, and the new type will be $C_{12}\,Fe_2\,M_2\,N_6$; while in the salts of Playfair, O_2 has replaced C_2, or $N\,O_2$, is substituted for $N\,C_2$, and the formula becomes $(C_{10}\,O_2)\,Fe_2\,M_2\,N_6$; a constitution which, in another form, Gerhardt has shown to correspond perfectly with the analytical results obtained by Playfair.

A similar view is extended to the nitric species of the hydrocarbons, and nitrobenzene, $C_{12}\,H_5\,N\,O_4$, is compared with bitter-almond oil, $C_{14}\,H_6\,O_2$, by writing its formula $(C_{12}\,O_2)\,(H_5\,N)\,O_2$. This novel suggestion seems deserving of farther attention.

In treating of the oxydating power of a solution of a ferricyanid with hydrate of potash, it is suggested that peroxyd of hydrogen is the oxydating agent, as the assimilation of 2K from $2K\,H\,O_2$ will give $H_2\,O_4$; and the same view is extended to the oxydizing action of moist chlorine, for $Cl_2+2H_2\,O_2=2H\,Cl+H_2\,O_4$.

The views of the constitution of the compound ammonias, and the bodies of the kakodyl series, which appeared in this Journal for March 1851, and were republished in the London Philosophical Magazine of May following, are here reproduced; and the newly discovered volatile base piperidine $C_{10}\,H_{11}\,N$, is noticed as homologous with arsine and stibethine. These alkaloids are to the ammonias, what aldehyd is to alcohol, differing by H_2. Strecker's fine researches on the bile are embodied, and the close association of the sulphur-acid with the other species, serves the author to illustrate his idea of the protein bodies, which he regards as mixtures of a species containing sulphur, with a normal species having the composition of an amid, or rather nitryl of cellulose, and represented by $C_{24}\,H_{17}\,N_3\,O_8$; so that it may produce $C_{24}\,H_{20}\,O_{20}$ and $3N\,H_3$ by taking up $6H_2\,O_2$. The different forms of protein are compared to the isomeric bodies, cellulose, starch, and dextrin.

Gelatin is regarded as a similar derivative of glucose, with four equivalents of ammonia, and to be $C_{24}\,H_{20}\,N_4\,O_8$, capable of regenerating grape sugar and ammonia by taking up $8H_2\,O_2$. These formulas, supported by a comparison with many analyses, and by the peculiar reactions of gelatin and protein, have already been published in this Journal,* and noticed with high commendation, by the editors of the Comptes Rendus des Travaux de Chimie, Messrs. Laurent and Gerhardt.†

There are many other subjects of interest in this little treatise, and we recommend its perusal to all chemical students.

2. *A Memoir on the Equinoctial Storms of March–April,* 1850: *an Inquiry into the extent to which the Rotatory Theory may be applied;* by F. P. B. Martin, Esq., (Athenæum, No. 1294.)—From the notices which have from time to time appeared in the pages of the *Athenæum* our readers have been made well acquainted with the main poitns of the theory of storms. The work before us—which is not published—

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* See this Journal for Jan., 1848, p. 74—Sept., 1848, p. 259, and Jan., 1849, p. 109.

† Comptes Rendus des Trav. for 1850, p. 317.

is a collection, from all available sources, of such information as tends to prove the correctness of the rotatory theory, as applied not merely to the storms of the tropics, but to those also which occasionally strew wrecks upon our own shores. An immense mass of information has been gathered together, consisting mainly of extracts from logs, meteorological registers, &c., which cannot but prove eminently useful to all who are interested in the solution of the problem. From a careful examination of Mr. Martin's examples and reasonings, we feel convinced of the correctness of his views. Further information is promised; and judging from the character of that before us, it is likely to be of much value. This would, however, be very considerably increased if the book were to pass through the hands of a publisher:—by which means a better style of printing would be insured, and the the book would be procurable by those who may require to consult its tables. [The theory advocated is essentially that of Mr. Redfield.]

3. *Curiosities of the Microscope;* or Illustrations of the Minute Parts of Creation; adapted to the capacity of the Young, with colored Illustrations; by Rev. Jos. WYTHES, M.D., author of the Microscopist, etc. 132 pp. Philadelphia, 1852. Lindsay & Blakiston.—This is a beautiful little book for children, beautiful in its printing, its colored plates and its whole getting up; and is well adapted to instruct and amuse those for whom it is intended. There are 12 plates, containing numerous figures, drawn with much care, even to minute details. The spirit of the work is excellent, and we wish it in the hands of all the children of the land.

4. *Analytical Physics, or Trinology;* a New Theory of Physical Science; by ROBERT FORFAR. 120 pp. 12mo. London, 1852. H. Baillière.—The author opposes the common doctrine of "attraction," arguing that cold is a positive agent distinct from heat, and that the two antagonistic elements, heat and cold constitute the motion-producing cause throughout the universe. Such a conclusion requires better evidence for its support than the author has brought forward.

5. *Lectures on the Electro-magnetic Telegraph, with an historical account of its rise and Progress*, containing a list of the number of Telegraphic lines of the world, illustrated by 56 wood cuts and 2 copper-plate engravings; with an Appendix containing the decisions of Judges Woodbury and Kane in the celebrated Telegraphic trials; by LAURENCE TURNBULL, M.D., Lecturer on Technical Chemistry at the Franklin Institute of Pennsylvania. 140 and 46 pp. 8vo. Philadelphia, 1852.—The different kinds of Electric Telegraphs are well illustrated and described in this work, with full details; and the elementary principles upon which they operate are explained so as to bring the whole subject within the comprehension of minds uneducated in science. The lines of Morse's Telegraph in the United States have a length of 15,835 miles; and House's and Bain's lines are each about 2,000 miles long, making in all 20,047 miles. In England, Scotland and Ireland, the whole length is stated at 2,150 miles; in Prussia, 1,493 miles; in Austria, 1,053 miles; in France, 400 to 600 miles.

6. *Annals of Science, being a Record of Inventions and Improvements in applied Science*, conducted by J. HAMILTON SMITH, A.M., Cleveland, Ohio, 1852. $1 a year.—The Annals of Science made its first

appearance on the 15th of October, and is issued in semi-monthly numbers of 16 pages, large 8vo. It is devoted to practical and theoretical science, treating, in its articles and selections, of the subjects of astronomy, geology, zoology, meteorology, physics, practical chemistry and the general applications of science, and is calculated to do much for the progress and diffusion of knowledge. Judging from the numbers which have been issued, and our personal acquaintance with the editor, Mr. Smith, we are assured that the work will be well conducted, and will thus commend itself to the favor and substantial support of all who care to know of the discoveries in science that are daily coming to light.

7. *Annals of the Astronomical Observatory of Georgetown College, D. C.;* No. I, containing the description of the Observatory, and the description and use of the Transit Instrument and Meridian Circle. 216 pp. 4to, with 8 plates.—The Observatory at Georgetown was erected mainly for the instruction of students, and this first volume of the Annals contains, as the author, Prof. James Curley, states in his preface, a simple account of what was done in building the house and mounting some of the instruments, and also a full explanation, adapted to young persons, of almost every thing connected with the Transit Instrument and Meridian circle; together with an explanation of the method of finding the difference of longitude by meridian observations of the moon and the stars near her. The longitude of the Observatory is stated at 77° 4′ 33″ west of Greenwich, and the latitude 38° 54′ 26″ north.

8. *The American Polytechnic Journal*, a new Monthly Periodical, devoted to Science, Mechanic Arts and Agriculture, conducted by Prof. CHAS. G. PAGE, M.D., late Chief Examiner of Patents, J. J. GREENOUGH, M.E., C. L. FLEISCHMANN, C.E.—This new Journal, the first number of which is annonnced to appear in January, is under the general supervision of Prof. Page, for the departments of Physical and Chemical Science, Mr. Greenough for the Mechanic Arts, and Mr. Fleischmann for Agriculture. This Journal has the advantage of high ability in its editorial corps, and from its practical character combined with scientific excellence, it must secure extended popularity, and prove of great value to the science and arts of the country. Its position at Washington, where the Patent Office is established, gives it great advantages. The monthly numbers will contain about 70 pages, and be fully illustrated by engravings.

9. *The Canadian Journal*, a Repository of Industry, Science and Art; and a Record of the Proceedings of the Canadian Institute. Toronto, Upper Canada. Published by H. Scobie, for the Council of the Canadian Institute.—A monthly 4to Journal, of the above title, was commenced at Toronto in August last. The departments of Practical and Scientific Agriculture, Mechanics, Geology, Chemistry and Physics are represented among the articles in the August and September numbers. We observe the name of Captain Lefroy, of the Toronto Observatory, among its contributors.

10. *Palæontographical Society.*—The Palæontographical Society has just issued a volume for 1852, containing a Monograph of the British Fossil Corals, by H. MILNE EDWARDS and JULES HAIME, 3d part, Corals from the Permian formation and the Mountain limestone, with 16 4to plates; a Monograph of British Tertiary Cretaceous, Oolitic

and Liassic Brachiopoda, by Thos. Davidson, Parts I, II, and III. with 18 plates; a Monograph of the Eocene Mollusca, or Descriptions of Shells from the older Tertiaries of England, by Frederick E. Edwards, Part II, Pulmonata, with 6 plates; a Monograph of the Echinodermata of the British Tertiaries, with 4 plates, by Prof. E. Forbes.

The illustrations of the publications of the Palæontographical Society are of remarkable beauty, and the works issued are worth—comparing them with the books of the trade—five times what they cost. By a payment of a guinea a year, any person is entitled to the volume or volumes of that year. To the geologist they are indispensable.

11. *Quarterly Journal of Microscopic Science*, including the Transactions of the Microscopical Society of London, edited by Edwin Lankester, M.D., F.R.S., F.L.S., and George Busk, F.R.C.S.E., F.R.S., F.L.S.—The first number of this Journal was issued in October. It contains various papers on microscopic subjects and is illustrated by four lithographs. It will be found a valuable acquisition to all who are interested in microscopic investigations, and to zoologists generally. The amateur microscopist is often in want of subjects for investigation, or needs a hint from some one skilled in science as to the objects of interest around him. The Journal of Microscopic Science coming to him quarterly will supply what in this respect he needs, besides giving the results of profound researches of microscopists abroad. We direct attention to the Prospectus of this Journal published with this number of our Journal.

12. Alexis Perrey, (Prof. à la Faculté des Sciences de Dijon.)—*Mémoire sur les Tremblements de Terre ressentis dans la Peninsule Turco-hellenique et en Syre.* From the Mem. Couronnés, etc., Acad. Roy. de Belgique, vol. xxiii.—Note sur les Tremblements de Terre ressentis, en 1847, 12 pp. 8vo; en 1848, 8 pp. 8vo, Bull. Acad. Roy. de Belg., vol. xvi; en 1849, suivie d'un Supplément pour 1847 et 1848, 22 pp. 8vo, Bull. Acad. Roy. de Belg., vol. xvii; en 1850, 20 pp. 8vo, Bull. Acad. Roy. de Belg., vol. xviii.

——— *Documents relatifs aux Tremblements de Terre dans le nord de l'Europe et de l'Asie.* St. Petersburg, Acad. Impér. des Sciences, 1849. 32 pp. 4to.

——— *Mémoires sur les Tremblements de Terre aux Etats-Unis et dans le Canada.* 62 pp. 8vo. Extrait des Annales de la Société d'Emulation, vol. vii, 1850.

Prof. Perrey, as the titles of his works shows, is engaged in a thorough investigation of earthquakes. His researches have been carried forward with great energy, and he already looks towards generalizations of much importance, with regard to the unequal prevalence of earthquakes in the different regions of the globe, in different years, and in the different months of the year. In his paper on American earthquakes, he has gone over the early historical documents relating to the country, and thereby he has brought together a great number of facts that had been forgotten. We should be glad to cite from this paper at length, had we space. It will be doing much for this department of science, if any persons having records of earthquakes or making observations at the present time, will send a copy of them to Prof. Perrey at Dijon. The facts will be most gladly welcomed by him, and will be placed on record in some of the journals of the day, or publications of societies.

13. *Norton's Literary Register*, 1853; by C. B. NORTON, New York. 12mo., 1852, 25 cts.—Mr. Norton by his Literary Advertiser, and the Register here issued, is doing much to distribute a knowledge of the Publications coming monthly from the Press both in this country and abroad. The Literary Register for 1853 contains a list of American and English publications for 1852, a list of Publishers, a Catalogue of the Libraries in the United States, with particular descriptions of the Libraries of Harvard College, Yale College, and Brown University, and of the Worcester Antiquarian Library, the New York State Library, and Redwood Library. An almanac for 1853 is also connected with the Register. The volume is prepared with care and will be found highly useful.

R. HOGG: British Pomology. *London.*

A. DE QUATREFAGES: Observations sur les Notiluques; Memoire sur la Phosphorescence de quelques Invertébrés marins; Etudes sur les Types Inferieurs de l'embranchement des Annelés. 170 pp. 8vo, with several plates. From the Ann. des Sci. Nat. [3], vol. xiv.

C. F. RAMMELSBERG: Lehrbuch der Krystallkunde, oder Anfangsgründe der Krystallographie, Krystallophysik und Krystallochemie. 236 pp. 8vo, with 250 woodcuts and 3 plates. *Berlin*, 1852.

G. FORCHHAMMER, J. STEENSTRUP and J. WORSAAE: Undersögelser i geologisk-antiqvarisk Retning. Fortsættelse Nr. 1. *Copenhagen*, 1852.

G. FORCHHAMMER: Hans Christian Œrsted; et Mindeskrift læst i det Kongelige danske Videnskabernes Selskabs Möde den 7de November, 1851. *Copenhagen*, 1852.

G. FORCHHAMMER: Oversigt over det Kgl. danske Videnskabernes Selskabs Forhandlinger, og dets Medlemmers Arbeider i Aaret, 1851. *Copenhagen.*

H. RINK: Om den geographiske Beskaffenhed af de danske Handelsdistrikter i Nordgrönland, tilligemed en Udsigt over Nordgrönlands Geognosi. 62 pp. 4to, with a chart. *Copenhagen*, 1852. Among the minerals of North Greenland there are noticed, hornblende, dolomite with tremolite, sahlite and actinolite, molybdena, titanite, idocrase, staurotide, mica, labradorite, anthophyllite $(\dot{F}e^3\,\ddot{S}i^2 + 3(\dot{M}g^3\,\ddot{S}i^2))$, a silicate of magnesia $((\dot{M}g, \dot{F}e)^6\,\ddot{S}i^5)$; also in connection with trap, chabasite, levyne, mesotype, stilbite, okenite, analcime, native copper, and chrysocolla, nephrite and jasper, calc spar, arragonite, quartz crystal and chalcedony.

PROCEEDINGS BOST. SOC. NAT. HIST.—October, 1852. p. 209. Skeleton of the Chimpanzee; p. 210. *C. Girard*, on Niobe (Girard) zonata, from the harbor of Boston, N. limacina (=Planaria limacina, *Fabr.*), Fovia (Girard) Warrenii, of Chelsea Beach, Dugesia Foremanii, from near Washington, D. C., Amphidetus Kürtzii.—p. 214.. Synapta pellucida, n. sp.; *Stimpson* and *Kürtz.*—p. 220. Officers for the ensuing year—J. C. Warren, President, C. T. Jackson and D. H. Storer, Vice Presidents, J. Eliot Cabot, Corresponding Secretary, N. B. Shurtleff, Treasurer, C. K. Dillaway, Librarian.—p. 222. Axius serratus, n. sp.; *Stimpson.*—p. 223. Remarks on the Ophisaurus ventralis; *Dr. Burnett.*—p. 224. Two new species of Ophiolepis; *Stimpson.*

JAHRESBERICHT DES NATURWISSENSCHAFTLICHEN VEREINES IN HALLE, 2nd year—June, 1849, 1850, 162 pp. 8vo, with 1 plate; 3d year, 1850, 190 pp. with 3 plates; 4th year, 1851, 306 pp. with 4 plates; 5th year, 1852, 1st and 2nd parts, 208 pp. with 3 plates.

BULLETIN DE LA SOCIÉTÉ IMPERIALE DES NATURALISTES DE MOSCOU, Nos. 3 and 4, 1851, and No. 1, 1852.—No. 3, contains papers on Russian Staptylinæ, by *I. H. Hochhuth*; undescribed Synanthereæ, by *Turczaninow*; new species of Daphnia, by *S. Fischer*; Limaces of Ukraine, etc., by *Kaleniczenko*; No. 4, contains Flora baicalensi-dahurica, by *Turczaninow*; new species of Cyclopidæ, by *S. Fischer*; Russian Lepidoptera, by *v. Nordmann*; on waves, by *A. Popoff*; new Caucasian Plants, Scthegleeff; new Coleoptera, by *Motschoulsky*, etc. No. 1, contains, new Carabaci, by *Chaudoir*; Russian Moths, by *Eversmann*; fossil fishes of Russia, with 2 plates, by *G. Fischer de Waldheim*; on waves, by *A. Popoff*; on the tyraïque system, 1st part Terrains hemelysiens, by *Andrzeiowski*, etc.

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The large and constantly increasing number of microscopical observers, and the demand for information relating to improvements in the Microscope, and discoveries made by its aid, have encouraged the belief that a Journal devoted entirely to researches prosecuted by this instrument would be welcomed not only by those who are professionally interested in its use, but by all who employ it for amusement and instruction. Although the branches of knowledge in which the Microscope is employed as an instrument of research are very various, yet it so happens that the departments of science in which it is used are precisely those most intimately connected with each other. It is on this ground that the Editors hope to meet with encouragement from various classes of labourers in the field of Science. No department of knowledge, inquiry in which can in any manner be assisted by the aid of the Microscope, will be neglected. In recording the forms of minute crystals, the molecular arrangement of mineral bodies, and the structure of fossil remains, the Editors hope to render assistance to the Chemist, Mineralogist, and Geologist. In the investigation of the tissues and functions of plants and animals, and the countless forms of microscopic creatures, they hope to interest the Botanist, Zoologist, and Physiologist; whilst in recording all that is being done by the Microscope for the elucidation of the minute structure of the human body in health, and the state of its fluids and solids in disease, they trust to be able to secure the support of the Medical Profession.

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[SECOND SERIES.]

Art. XIX.—*On Changes of Level in the Pacific Ocean*; by James D. Dana.*

Evidences of change of level in the Pacific are to be looked for in the height or condition of the coral reef formations or deposits; in the character of the igneous rocks; and in the features of the surface. The points of evidence are as follows:—

A. Evidences of elevation.

1. *Patches of coral reef, or deposits of shells and sand from the reefs, above the level where they are at present forming.*

The coral reef-rock has been shown occasionally to increase by growth of coral, to a height of four to six inches above low tide level when the tide is but three feet, and to twice this height with a tide of six feet. It may, therefore, be stated as a general fact that the limit to which coral *may* grow above ordinary low tide, is about one-sixth the height of the tide, though it seldom attains this height.

Beach accumulations of large masses seldom exceed *eight* feet above high tide, and the finer fragments and sand may raise the deposit to ten feet. But with the wind and waves combined, or on prominent points where these agents may act from opposite directions, such accumulations may be *thirty* to *forty* feet in height. These are drift deposits, finely laminated, generally with a sandy texture, and commonly without a distinguishable

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* This article, cited from a chapter in the author's Expl. Exp. Geological Report, is a continuation of the previous papers on the Pacific Islands, xi, 357, xii, 25, 165, 329, xiii, 34, 185, 338, and xiv, 76.

fragment of coral or shell; and in most of these particulars they are distinct from reef-rocks. (pp. 369, 370, vol. xi.)

2. *Sedimentary deposits, or layers of rolled stones interstratified among the igneous layers.*

3. *Compactness of the igneous rocks.*—The great uncertainty of this kind of evidence has been shown in another place.

B. Evidences of Subsidence.

1. *The existence of wide and deep channels between an island and any of its coral reefs;* or in other words, *the existence of barrier reefs.*

2. *Lagoon Islands or Atolls.*

3. *Submerged atolls.*

4. *Deep bay-indentations in coasts as the terminations of valleys.*—In the remarks upon the valleys of the Pacific Islands, it has been shown that they were in general formed by the waters of the land, unaided by the sea; that the sea tends only to level off the coast, or give it an even outline. When therefore, we find the several valleys continued on beneath the sea, and their enclosing ridges standing out in long narrow points, there is reason to suspect that the island has subsided after the formation of its valleys. For such an island as Tahiti could not subside even a few scores of feet without changing the even outline into one of deep coves or bays, the ridges projecting out to sea on every side, like the spread legs of a spider. The absence of such coves, on the contrary, is evidence that any subsidence which has taken place, has been comparatively small in amount.

5. *Seashore alluvial flats or deposits.*

6. *The lava surface of a volcanic island, sloping without interruption beneath the water, instead of terminating in a shore cliff of a hundred feet or so.*

C. Probable evidence of subsidence now in progress.

1. *An atoll reef without green islets, or with but few small spots of verdure.*—The accumulation requisite to keep the reef at the surface-level, during a slow subsidence, renders it impossible for the reef to rise above the waves unless the subsidence is extremely slow.

From the above review of evidences of change of level, it appears that where there are no *barrier* reefs, and only fringing reefs, the corals afford no evidence of subsidence. But it does not follow that the existence of only fringing reefs, or of no reefs at all, is proof *against* a subsidence having taken place. For we have elsewhere shown that through volcanic action, and at times, other causes, corals may not have begun to grow till a recent period, and, therefore, we learn nothing from them as to what may previously have taken place. While, therefore, a distant barrier is evidence of change of level, we can draw no conclusion either one way or the other, as is done by Darwin, from the fact that the reefs are small or wholly wanting, until the possible operation of the several causes limiting their distribution has been duly considered.

The influence of volcanoes in preventing the growth of zoophytes, extends only so far as the submarine action may heat the water, and it may, therefore, be confined within a few miles of a volcanic island, or to certain parts only of its shores.

There are three epochs of changes in elevation which may be distinguished and separately considered. 1. The subsidence indicated by atolls and barrier reefs. 2. Elevations during more recent periods, and also during the same epoch of subsidence. 3. Changes of level anterior to the atoll subsidence and the growth of recent corals. On this last point, we have few facts.

1. *Subsidence indicated by atolls and barrier reefs.*

In a survey of the ocean, the eye observing its numerous atolls, sees in each, literally as well as poetically, a coral urn upon a rocky island that lies buried beneath the waves. Through the equatorial latitudes, such marks of subsidence abound, from the Eastern Paumotu to the Western Carolines, a distance of about six thousand geographical miles. In the Paumotu Archipelago there are about eighty of these atolls. Going westward, a little to the north of west, they are found to dot the ocean at irregular intervals; and at the Tarawan Group, the Carolines commence, which consist of seventy or eighty atolls.

If a line be drawn from Pitcairn's island, the southernmost of the Paumotus, by the Gambier Group, the north of the Society Group, Samoa, and the Salomon Islands to the Pelews, it will form nearly a straight boundary trending N. 70° W., running between the atolls on one side and the high islands of the Pacific on the other, the former lying to the North of the line, and the latter to the South.

Between this boundary line and the Hawaiian Islands, an area nearly two thousand miles wide and six thousand long, there are two hundred and four islands, of which *only three are high* exclusive of the eight Marquesas. These three are Ualan, Banabe (Ascension or Pounypet) and Hogoleu, all in the Caroline Archipelago. South of the same line, within three degrees of it, there is an occasional atoll; but beyond this distance, there are none excepting the few in the Friendly Group, and one or two in the Feejees.

If each coral island scattered over this wide area indicates a subsidence of an island, we may believe that the subsidence was general throughout the area. Moreover, each atoll, could we measure the thickness of the coral constituting it, would inform us nearly of the extent of the subsidence where it stands; for they are actually so many registers placed over the ocean, marking out not only the site of a buried island, but also the depth at which it lies covered. We have not the means of applying the evidence; but there are facts at hand, which may give at least comparative results.

a. We observe, *first*, that barrier reefs are, in general, evidence of less subsidence than atoll reefs. (xiii, 186.) Consequently the great preponderance of the former just below the southern boundary line of the coral island area, and farther south the entire absence of atolls, while atolls prevail so universally north of this line, are evidence of little depression just below the line; of less farther south; and of the greatest amount, north of the line or over the coral area.

b. The subsidence producing an atoll, when continued, gradually reduces its size, until finally it becomes so small that the lagoon is obliterated; and consequently a prevalence of these small islands is presumptive evidence of the greater subsidence. We observe, in application of this principle, that the coral islands about the equator, five or ten degrees south, between the Paumotus and the Tarawan Islands, are the smallest of the ocean: several of them are without lagoons, and some not a mile in diameter. At the same time, in the Paumotus, and among the Tarawan and Marshall Islands, there are atolls twenty to fifty miles in length, and rarely one less than three miles. It is probable, therefore, that the subsidence indicated was greatest at some distance north of the boundary line, over the region of small equatorial islands, between the meridian of 150° W. and 180°.

c. When after thus reducing the size of the atoll, the subsidence continues its progress, or when it is too rapid for the growing reef, it finally sinks the coral island, which, therefore, disappears from the ocean. Now it is a remarkable fact that while the islands about the equator above alluded to indicate greater subsidence than farther south, north of these islands, that is, between them and the Hawaiian Group, there is a wide blank of ocean without an island, which is near twenty degrees in breadth. This area lies between the Hawaiian, the Fanning and the Marshall islands, and stretches off between the first and last of these groups, far to the northwest.

Is it not then a legitimate conclusion that the subsidence which was least to the south beyond the boundary line, and increased northward, was still greater or more rapid over this open area; that the subsidence which reduced the size of the islands about the equator to mere patches of reef, was farther continued, and caused the total disappearance of islands that once existed over this part of the ocean?

d. That the subsidence gradually diminished southwestwardly from some point of greatest depression situated to the northward and eastward, is apparent from the Feejee Group alone. Its northeast portion, as the chart shows, (see vol. xiv,) consists of immense barriers, with barely a single point of rock remaining of the submerged land; while in the west and southwest there are basaltic islands of great magnitude. Again, along to the north side of the Vanikoro Group, the Salomon Islands, and New Ireland, there are coral atolls, though scarcely one to the south.

In view of this combination of evidence, we cannot doubt that the subsidence increased from the south to the northward or northeastward, and was greatest between the Samoan and Hawaiian Islands near the centre of the area destitute of islands, about longitude 170° to 175° W. and 8° to 10° N.

But we may derive some additional knowledge respecting this area of subsidence from other facts.

Hawaiian Range.—We observe that the western islands in the Hawaiian Range, beyond Bird Island, are coral islands, and all indicate some participation in this subsidence. To the eastward in the range, Kauai and Oahu have only fringing reefs, yet in some places these reefs are half a mile to three-fourths in width. They indicate a long period since they began to grow, which is borne out by the features of Kauai showing a long respite from volcanic action. We consequently detect proof of but little subsidence of the islands. Moreover, there are no deep bays: and, besides, Kauai has a gently sloping coast plain of great extent, with a steep shore acclivity of one to three hundred feet, all tending to prove the smallness of the subsidence. We should, therefore, conclude that these islands lie near the limits of the subsiding area, and that the change of level was greatest at the western extremity of the range beyond Kauai.

Marquesas.—The Marquesas are remarkable for their abrupt shores, often inaccessible cliffs, and deep bays. The absence of gentle slopes along the shores, their angular features, abrupt soundings close alongside the islands, and deep indentations, all bear evidence of subsidence to some extent; for their features are very similar to those which Kauai or Tahiti would present, if buried half its height in the sea, leaving only the sharper ridges and peaks out of water. They are situated but five degrees north of the Paumotus, where eighty islands or more have disappeared, including one at least fifty miles in length. There is sufficient evidence that they participated in the subsidence of the latter, but not to the same extent. They are nearly destitute of coral.

Gambier or Mangareva Group.—In the Southern limits of the Paumotu Archipelago, where, in accordance with the foregoing views, the least depression in that region should have taken place, there are actually, as we have stated, two high islands, *Pitcairn's* and *Gambier's.* There is evidence, however, in the extensive barrier about the *Gambier's* (see cut, vol. xiii, p. 130), that this subsidence, although less than farther north, was by no means of small amount. On page 371, vol. xi, we have estimated it at 1150 feet. These islands, therefore, although towards the limits of the subsiding area, were still far within it. The valley-bays of the Mangareva islets are of great depth, and afford additional evidence of the subsidence.

Tahitian Islands.—The Tahitian Islands, along with Samoa and the Feejees, are near the southern limits of the area pointed out. Twenty-five miles to the north of Tahiti, within sight from its peaks, lies the coral island Tetuaroa, a register of subsidence. Tahiti itself, by its barrier reefs, gives evidence of the same kind of change; amounting, however, as we have estimated, to a depression of but two hundred and fifty or three hundred feet. The northwestern islands of the group lie more within the coral area, and correspondingly, they have wider reefs and channels, and deep bays, indicating a greater amount of subsidence.

Samoa.—The island of Upolu has extensive reefs, which, in many parts, are three-fourths of a mile wide, but no inner channel. We have estimated the subsidence at one or two hundred feet. The volcanic land west of Apia declines with an unbroken gradual slope of one to three degrees beneath the sea. The absence of a low cliff is probable evidence of a depression, as has been elsewhere shown. The island of Tutuila has abrupt shores, deep bays and little coral. It appears probable, therefore, that it has experienced a greater subsidence than Upolu. Yet the central part of Upolu has very similar bays on the north, which would afford apparently the same evidence; and it is quite possible that the facts indicate a sinking which either preceded the ejections that now cover the eastern and western extremities of Upolu, or accompanied this change of level. Savaii has small reefs, from which we gather no certain facts bearing on this subject. East of Tutuila is the coral island, Rose. It may be therefore, that the greatest subsidence in the group was at its eastern extremity.

Feejee Islands.—We have already remarked upon this group. A large amount of subsidence is indicated by the reefs in every portion of the group, but it was greatest beyond doubt in the northeastern part.

Ladrones.—The Ladrones appear to have undergone their greatest subsidence at the north extremity of the range, the part nearest the centre of the coral area: for although the fires at the north have continued longest to burn, the islands are the smallest of the group, the whole having disappeared except the summits, which still eject cinders. The southern islands of the group have wide reefs, but they afford no good evidence of any great extent of subsidence since the reefs began to form.

We have thus followed around the borders of the coral area: and besides proving the reality of the limits, have ascertained some facts with reference to a gradual diminution of the subsidence towards and beyond these limits. A line from Pitcairns to Bird in the Hawaiian Group appears to have a corresponding position on the northeast with the southern boundary line of the coral area; the two include a large triangular area. An axis nearly bisecting this triangular space, drawn from Pitcairns towards Japan, actually passes through the region of greatest subsidence, as we have before determined it, and may be considered the *axial line* or *line of greatest depression* for the great area of subsidence.

It is worthy of special note, *that this axial line or line of greatest depression coincides in direction with the mean trend of the great ranges of islands, it having the course* N. 52° W.

The southern boundary line of the coral area, as we have laid it down, lies within the area of subsidence, although near its limits. There are places along this line where this area has been prolonged farther than elsewhere. One of these regions lies between Samoa and Rotuma, and extends down to the Feejees and Tonga Group; another is east of Samoa, reaching towards the Hervey Group. Each of these extensions trends parallel with the groups of islands; and with the part of the line east of Tahiti. It would seem, therefore, that the Society and Samoa islands were regions of less change of level than the deep seas about them.

What may be the Extent of the Coral Subsidence?—It is very evident that the sinking of the Society, Samoan, and Hawaiian Islands has been small compared with that required to submerge all the lands on which the Paumotus and the other Pacific atolls rest. One, two, or five hundred feet could not have buried all the many peaks of these islands. Even the 1500 feet of depression at the Gambier Group is shown to be at a distance from the axis of the subsiding area. The groups of high islands above mentioned contain summits from 4000 to 14,000 feet above the sea; and can we believe it possible that throughout this large area, when the two hundred islands now sunk were above the waves, there were none equal in altitude to the mean of these heights? That all should have been within nine thousand feet in elevation, is by no means probable. However moderate our estimate, there must still be allowed a sinking of several thousand feet: and however much we increase it within probable bounds, we shall not arrive at a more surprising change of level than our continents show that they have undergone.

Between the New Hebrides and Australia the reefs and islands mark out another area of depression, which may have been simultaneously in progress. The long reef of one hundred and fifty miles from the north cape of New Caledonia and the wide barrier on the west cannot be explained without supposing a subsidence of one or two thousand feet at the least. The distant barrier of New Holland is proof of as great if not greater subsidence.

Effect of the Subsidence.—The facts surveyed give us a long insight into the past, and exhibit to us the Pacific scattered over with lofty lands where there are now only humble monumental atolls. Had there been no growing coral, the whole would have passed without a record. These permanent registers, planted ages past in various parts of the tropics, exhibit in enduring characters the oscillations which the "stable" earth has since undergone. Thus Divine wisdom creates and makes the creations inscribe their own history; and there is a noble pleasure in deciphering even one sentence in this Book of Nature.

From the actual extent of the coral reefs and islands, we know that the whole amount of high land lost to the Pacific by the subsidence, was at least fifty thousand square miles. But since atolls are necessarily smaller than the land they cover, and the more so, the farther subsidence has proceeded;—since many lands from their abrupt shores, or through volcanic agency must have had no reefs about them, and have disappeared without a mark; and others may have subsided too rapidly for the corals to retain themselves at the surface; it is obvious that this estimate is far below the truth. It is apparent that in many cases, islands now disjoined, have been once connected, and thus several atolls may have been made about the heights of a single subsiding land of large size. Such facts show farther error in the above estimate, evincing that the scattered atolls and reefs do not tell half the story. Why is it, also, that the Pacific islands are confined to the tropics, if not that beyond thirty degrees the zoophyte could not plant its growing registers?

Yet we should beware of hastening to the conclusion that a continent once occupied the place of the ocean, or a large part of it, which is without proof. To establish the former existence of a Pacific continent is an easy matter for the fancy; but geology knows nothing of it, nor even of its probability.

The island of Banabe in the Caroline archipelago affords evidence of a subsidence *in progress*, as my friend, Mr. Horatio Hale, the Philologist of the Expedition, gathered from a foreigner who had been for a while a resident on this island. Mr. Hale remarks, after explaining the character of certain sacred structures of stone: "It seems evident that the constructions at Ualan and Banabe are of the same kind, and were built for the same purpose. It is also clear that when the latter were raised, the islet on which they stand was in a different condition from what it now is. For at present they are actually in the water; what were once paths, are now passages for canoes, and as O'Connell [his informant] says, 'when the walls are broken down the water enters the inclosures.'" Mr. Hale hence infers "that the land, or the whole group of Banabe, and perhaps all the neighboring groups, have undergone a slight depression." He also states respecting a small islet near Ualan, "From the description given of Leilei, a change of level of one or two feet would render it uninhabitable, and reduce it, in a short time, to the same state as the isle of ruins at Banabe."

Period of the subsidence.—The period during which these changes were in progress, was probably since the tertiary epoch. In the island of Metia, elevated over two hundred feet, the corals below were the same as those now existing, as far as we could judge from the fossilized specimens. At the inner margin of shore reefs, there is the same identity with existing genera. We do not claim to have examined the basement of the coral islands, and offer these facts as the only evidence on this point that is within reach. We cannot know with absolute certainty that the present races of zoophytes may not be the successors of others of the secondary epoch: but we do know that we have little reason in facts observed for even the suspicion. For a long time volcanic action was too general and constant for the growth of corals: and this may have continued to interfere till a comparatively late period, if we may judge from the appearance of the rocks, even on Tahiti.

The evidence of subsidence from coral islands might be pursued to other regions in other seas; but we here only refer to the facts on this point presented in our review of the geographical distribution of corals, (xiii, 338,) since we cannot speak from personal observation.

The subsidence has probably for a considerable period ceased in most if not all parts of the ocean, and subsequent elevations of many islands and groups have taken place which we shall soon consider. In some of the Northern Carolines, the Pescadores, and perhaps some of the Marshall Islands, the proportion of dry land is so very small compared with the great extent of the atoll, that there is reason to suspect a slow sinking even at the present time: and it is a fact of special interest in connection with it that this region is near the axial line of greatest depression, where, if in any part, the action should be longest continued.

Among the Kingsmills and Paumotus there is no reason whatever for supposing that a general subsidence is still in progress; the changes indicated are of a contrary character.

The results to which we have here been led obviously differ in many particulars from the deductions of Mr. Darwin.

2. *Elevations of Modern Eras in the Pacific.*

Since the period of subsidence, the history of which has occupied us in the preceding pages, there has been no equally general elevation. Yet various parts of the ocean bear evidence of changes confined to particular islands or groups of islands. While the former exemplify one of the grander events in the earth's history, in which a large segment of the globe was concerned, the latter exhibit its minor changes over limited areas. The instances of these changes are so numerous and so widely scattered, that they convince us of a cessation in the previous general subsidence.

The most convenient mode of reviewing the subject is to state in order, the facts relating to each group.

a. Paumotu Archipelago.—The islands of this archipelago appear in general to have that height which the ocean may give to the materials. Nothing was detected which satisfied us of any *general* elevation in progress through the archipelago. The large extent of wooded land shows only that the islands have been long at their present level: and on this point our own observations confirm those of Mr. Darwin. There are examples of elevation in particular islands however, some of which are of unusual interest. The instances examined by the Expedition, were Honden (or Henuake), Dean's Island (or Nairsa), Aurora (or Metia), and Clermont Tonnerre. Beside these, Elizabeth Island has been described by Beechey, and the same author mentions certain facts relating to Ducie's Island and Osnaburgh, which afford some suspicions of a rise.

Honden or Dog Island.—This island is wooded on its different sides, and has a shallow lagoon. The beach is eight feet high and the land about eleven. There are three entrances to the lagoons, all of which were dry at low water, and one only was filled at high water. Around the lagoon, near the level of high tide, there were numerous shells of Tridacna lying in cavities in the coral rock, precisely as they occur alive on the shore reef. As these Tridacnas evidently lived where the shells remain, and do not occur alive more than six or eight inches, or a foot at the most, above low tide, they prove, in connection with the other facts, an elevation of *twenty inches* or *two feet.*

Nairsa or Dean's Island.—The south side of Dean's island, the largest of the Paumotus, was coasted along by the Peacock, and from the vessel we observed that the rim of land consisted for miles of an even wall of coral rock, apparently six or eight feet above high tide. This wall was broken into rude columns, or excavated with arches and caverns; in some places the sea had carried it away from fifty to one hundred rods and then there followed again a line of columns and walls, with occasional arches as before. The reef, formerly lying at the level of low tide, had been raised above the sea, and subsequently had undergone degradation from the waves. The standing columns had some resemblance in certain parts to the masses seen here and there on the shore platforms of other islands; but the latter are only distantly scattered masses, while on this island, for the greater part of the course, there were long walls of reef-rock. The height moreover was greater, and they occurred too on the *leeward* side of the island, ranging along nearly its whole course.

The elevation here indicated was at least *six feet;* but it may have been larger, as the observations were made from ship-board. Thirty miles to the southward of Dean's Island, we came to Metia, one of the most remarkable examples of elevation in the Pacific.

Metia.—This island has already been described, and its elevation stated at *two hundred and fifty feet.* (See xii, 40.)

Clermont Tonnerre,[*] according to Mr. Couthouy, shows the same evidence of elevation from Tridacnas as Honden Island. Clermont Tonnerre and Honden are in the northeastern limits of the Paumotus.

Elizabeth Island was early shown to be an elevated coral island by Beechey. This distinguished voyager represents it as having perpendicular cliffs fifty feet in height. From his description, it is obviously of the same character as Metia; the elevation is *eighty* feet.

Ducie's Island is described by Beechey as twelve feet high, which would indicate an elevation of at least *one* or *two* feet.

Osnaburgh Island, according to the same author, affords evidence of having increased its height since the wreck of the Matilda in 1792. He contrasts the change from "a reef of rocks," as reported by the crew, to "a conspicuously wooded island," the condition when he visited it; and states further, that the anchor, iron-works, and a large gun (4-pounder) of this vessel were two hundred yards inside of the line of breakers. Captain Beechey suggests that the coral had grown, and thus increased the height. But this process might have buried the anchor if the reef were covered with growing corals, (which is improbable,) and could not have raised its level. If there has been any increase of height, (which we do not say is certain,) it must have arisen from subterranean action.

b. Tahitian Group.—The island of Tahiti presented us no conclusive evidence of elevation. The shore plains are said to rest on coral, which the mountain debris has covered; but they do not appear to indicate a rise of the land. The descriptions by different authors of the other islands of this group, do not give sufficient reason for confidently believing that any of them have been elevated. The change, however, of the barrier reef around Bolabola into a verdant islet encircling the island, may be evi-

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[*] This island was not visited by the writer, as only the officers of the Vincennes attempted to land on it.

dence that a long period has elapsed since the subsidence ceased; and as such a change is not common in the Pacific, we may suspect that it has been furthered by at least a small amount of elevation. The observation by the Rev. D. Tyerman with regard to the shells found at Huahine high above the sea, may be proof of elevation; but the earlier erroneous conclusions with regard to Tahiti, teach us to be cautious in admitting it without a more particular examination of the deposit.

c. *Hervey and Rurutu Groups.*—These groups lie to the southwest and south of Tahiti.

Atiu (Wateoo of Cook) is a raised coral island. Cook observes that it is "nearly like Mangaia." The land near the sea is only a bank of coral ten or twelve feet high, and steep and rugged. The surface of the island is covered with verdant hills and plains, with no streams.[*]

Mauke is a low elevated coral island.[†]

Mitiaro resembles Mauke.[‡]

Okatutaia is a low coral island, not more than six or seven feet high above the beach, which is coral sand. It has a light-reddish soil.

Mangaia is girted by an elevated coral reef *three hundred* feet in height. Mr. Williams speaks of it as coral, with a small quantity of fine-grained basalt in the interior of the island; he states again that a broad ridge (the reef) girts the hills.[§]

Rurutu has an elevated coral reef *one hundred and fifty* feet in height.[‖]

With regard to the other islands of these groups, *Manuai*, *Aitutaki*, *Rarotonga*, *Rimetara*, *Tubuai*, and *Raivavai*, the descriptions by Williams and Ellis appear to show that they have undergone no recent elevation.

d. *Scattered Islands in the latitudes between the Society and Samoan Groups.*—These coral islands, as far as we can ascertain, are low like the Paumotus, excepting some of the Fanning Group north of the equator, and possibly Jarvis and Malden.

Of the *Fanning Group*, (situated near the equator, south of the Hawaiian Group,)

Washington Island is three miles in diameter, without a proper lagoon; the whole surface, as seen by us, was covered densely

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[*] Cook's Voyage, vol. i, pp. 180, 197. Williams's Miss. Enterprises, i, 47, 48, first Am. edit., Appleton.

[†] Williams's Miss. Ent., pp. 39, 47, 264.

[‡] Ibid. pp. 39, 264.

[§] Williams's Miss. Ent., pp. 48, 50, 249. See also Mr. Darwin, p. 132.

[‖] Williams's Miss. Ent., p. 50.—Stutchbury describes the coral rock as one hundred and fifty feet high. West of England Journal, i.—Tyerman and Bennet describe the island as having a high central peak with lower eminences, and speak of the coral rock as two hundred feet high on one side of the bay and three hundred on the other (ii, 102).—Ellis says that the rocks of the interior are in part basaltic, and in part vesicular lava, iii, 393.

with cocoanut trees. This unusual size for an island without a lagoon indicates an elevation, which the height of the island, estimated at twelve feet, confirms. The elevation may have been *two* or *three* feet.

Palmyra Island, just northwest of Washington, is described by Fanning as having two lagoons; the westernmost contains twenty fathoms water. *Fanning's Island*, to the southeast of Washington, is described by the same voyager as lower than that island. The accounts give no evidence of elevation.

Christmas Island, still farther to the southeast, according to the description of Cook, its discoverer, had the rim of land in some parts three miles wide. He mentions narrow ridges lying parallel with the sea-coast, which "must have been thrown up by the sea, though it does not reach within a mile of some of these places." The proof of a small elevation is decided, but its amount cannot be determined from the description. The account of F. D. Bennett, (Geographical Jour., vii, 226,) represents it as a low coral island.

Jarvis Island, as seen from the Peacock, appeared to be eighteen or twenty feet in height, which, if not exaggerated by refraction, (we think it not probable,) would show an elevation of six or eight feet. This island is a sand flat, with little vegetation, and is but two hundred miles south of Christmas Island.

Malden, two hundred and fifty miles southeast of Jarvis, near latitude 4° S. and longitude 155° W., visited by Lord Byron, is described as not over forty feet high; but this may be the whole height, including the height of the trees.

e. *Tonga Islands and others in their vicinity.*

All the islands of the Tonga group about which there are reefs, give evidence of elevation: *Tongatabu* and the *Hapai* islands consist solely of coral, and are elevated atolls.

Eua, at the south extremity of the line, has an undulated, mostly grassy surface, in some parts eight hundred feet in height. Around the shores, as was seen by us from shipboard, there is an elevated layer of coral reef-rock, twenty feet thick, worn out into caverns, and with many spout-holes. Between the southern shores and the highest part of the island, we observed three distinct terraces. Coral is said to occur at a height of three hundred feet. From the appearance of the land, we judged that the interior was basaltic; but nothing positive was ascertained with regard to it.

Tongatabu (an island visited by us) lies near Eua, and is in some parts fifty or sixty feet high, though in general but twenty feet. It has a shallow lagoon, into which there are two entrances; some hummocks of coral reef-rock stand eight feet out of water.

Namuka and most of the *Hapaii* cluster, are stated by Cook to have abrupt limestone shores, ten to twenty feet in height.

Namuka has a lagoon or salt lake at centre one and a half miles broad; and there is a coral rock in one part twenty-five feet high.*

Vavau, the northern of the Group, according to Williams, is a cluster of elevated islands of coral limestone, thirty to one hundred feet in height, having precipitous cliffs, with many excavations along the coast.†

Pylstaart's Island, south of Tongatabu, is a small rocky islet without coral. Tafua and Proby are volcanic cones, and the former is still active.

Savage Island, a little to the east of the Tonga Group, resembles Vavau in its coral constitution and cavernous cliffs. It is elevated *one hundred feet.*‡

Beveridge Reef, a hundred miles southeast of Savage, is low coral.

f. Samoan Islands.—No satisfactory evidences of elevation were detected about these islands.

g. Scattered Islands, north of Samoa.

These islands are all of coral, and several indicate an elevation of one to six feet. On account of the high tides, (4 to 6 feet,) the sea may give a height of ten or twelve feet to the land.

Swain's, near latitude 11° S., is fifteen to eighteen feet above the sea, where highest, and the beach is ten to twelve feet high. It is a small island, with a depression at centre, but no lagoon. The height proves an elevation of *three to six* feet.

Fakaafo, ninety miles to the north, is fifteen feet high. The coral reef-rock is raised in some places three feet above the present level of the platform. Elevation at least *three* feet.

Nukunono, or Duke of Clarence, near Fakaafo, was seen only from shipboard.

Oatafu, or Duke of York's, is in some parts fourteen feet high. Elevation *two* or *three* feet.

Enderby's and *Birnie's*, still farther north, are twelve feet high. Judging from the double slope of the beach on Enderby, this island may have undergone an elevation of *two* feet, the height of the upper slope; yet we think it doubtful.

Gardner's, *Hull*, *Sydney* and *Newmarket* were visited by the Expedition, but no satisfactory evidences of elevation on the first three were observed. The last is stated by Captain Wilkes to be *twenty-five* feet in height.

h. Feejee Islands.—The proofs of an elevation of four to six feet about the larger Feejee Islands, Viti Lebu and Vanua Lebu, and also Ovalau, are given in our report on this group. How

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* Cook's Voyage.—Williams, p. 296. † Williams, p. 427.

‡ Williams, pp. 275, 276. Foster estimates the height at fifty feet, and speaks of a depression about the centre.

far this rise affected other parts of the group, I have been unable definitely to determine: but as the extensive barrier reefs in the eastern part of the group, rarely support a green islet, they rather indicate a subsidence in those parts than an elevation.

i. Islands north of the Feejees.—Horne Island, Wallis, Ellice, Depeyster, and four islands on the track towards the Kingsmills, were passed by the Peacock; but from the vessel, no evidences of elevation could be distinguished. The first two are high islands, with barriers, and the others are low coral. *Rotuma*, (177° 15′ E., and 12° 30′ N.,) is another high island, to the west of Wallis's. It has encircling reefs, but we know nothing as to its changes of level.

k. Sandwich Islands.—*Oahu* affords decided proof of an elevation of twenty-five or thirty feet. There is an impression at Honolulu, derived from a supposed increasing height in the reef off the harbor, that the island is slowly rising. Upon this point I can offer nothing decisive. The present height of the reef is not sufficiently above the level to which it might be raised by the tides, to render it certain, from this kind of evidence, that the suspected elevation is in progress.

Kauai presents us with no evidence that the island, at the present time, is at a higher level than when the coral reefs begun: or at the most, no elevation is indicated beyond a foot or two. The drift sand rock of Koloa appears to be a proof of elevation, from its resemblance to those of Northern Oahu: but if so, there must have been a subsidence since, as it now forms a cliff on the shore that is gradually wearing away.

Molokai, according to information from the Rev. Mr. Andrews, has coral upon its declivities three hundred feet above the sea. The same gentleman informed us that on the western peninsula of *Maui*, coral occurs in some places eight hundred feet above the sea; and specimens of well defined coral were obtained at a height of five hundred feet. These islands were not visited by the writer.

With regard to *Molokai*, Mr. Andrews informed the author that the coral occurs "upon the acclivity of the eastern or highest part of the island, over a surface of more than twenty or thirty acres, and extends almost to the sea. We had no means of accurately measuring the height; but the specimens were obtained at least three hundred feet above the level of the sea, and probably four hundred. The specimens have distinctly the structure of coral. The distance from the sea was two to three miles."

Mr. Andrews, who appears to doubt the connection of the supposed coral on *Maui* with reefs, writes to the author as follows: "In no case have I seen the coral in a rocky ledge; it is generally mixed with the lava rock, to which it adheres. It has usually the appearance of burnt lime; and thus, large stones and rocks seem as though they had been whitewashed several times over, and sometimes it amounts to an inch in thickness, or an inch and a half. At other times the whitewash has found its way into cracks in the stones. Sometimes only one side of a stone is whitened by it, or only a corner of it. It is sometimes soft and crumbly, and at other times quite hard; and again it is mixed with the earth." From this description it appears to resemble the lime incrustations and seams of Diamond Hill, Punchbowl and Koko Head, Oahu, which occur at the same height, but most certainly give no evidence of elevation, as they have proceeded beyond doubt from aqueous eruptions carrying lime in solution. Fragments of coral, it will be remembered, occur in the tufa of these hills. This evidence from Maui, should therefore be received with great hesitation until farther examined.

Besides the above, there are large masses of coral rock, according to Mr. Andrews, along the shores of Maui, from *two* to *twelve* feet above high water. From his descriptions, this rock appears to be the reef-rock, like the raised reef of Oahu, and is probably proof of an elevation of at least *twelve* feet.

l. Kingsmill or Tarawan Group. (Plate I, Vol. xii.)

Taputeouea or Drummond.—This is the southern island of the group. The reef rock near the village of Utiroa is a foot above low tide level, and consists of large massive Astreas and Meandrinas. The tide in the Kingsmill seas is seven feet; and consequently this evidence of a rise might be doubted, as some corals may grow to this height where the tide is so high. But these Astreas and Meandrinas, as far as observed by the writer, are not among the species that may undergo exposure at low tide, except it be to the amount of three or four inches; and it is probable that an elevation of at least *ten* or *twelve* inches has taken place.

Apia or *Charlotte's* Island, one of the northernmost of the group, has the *reef-rock* in some parts raised bodily to a height of six or seven feet above low water level, evidencing this amount of elevation. This elevated reef was observed for long distances between the several wooded islets; it resembled the south reef of Nairsa in the Paumotu Archipelago in its bare, even top, and bluff worn front. An islet of the atoll, where we landed, was twelve feet high, and the coral *reef-rock* was five or six feet above middle tide. A wall of this rock, having the same height extends along the reef from the islet. There was no doubt that it was due to an actual uplifting of the reef to a height of full *six* feet.

Nanouki, *Kuria*, *Maiana* and *Tarawa* lying between the two islands above mentioned, were seen only from the ship, and nothing decisive bearing on the subject of elevation was observed. On the northeast side of Nanouki there was a hill twenty or thirty feet in height covered with trees; but we had no means of learning that it was not artificial. We were, however, informed by Kirby, a sailor taken from Kuria, that the reef of *Apamama* was elevated precisely like that of Apia, to a height of *five* feet; and this was confirmed by Lieutenant Dehaven, who was engaged in the survey of the reef. We were told, also, that Kuria and Nanouki were similar in having the reef elevated though to a less extent. It would hence appear that the elevations in the group increase to the northward.

Maraki, to the north of Apia, is wooded throughout. We sailed around it without landing, and can only say that it has probably been uplifted like the islands south. *Makin*, the northernmost island, presented in the distant view no certain evidence of elevation.

The elevation of the Kingsmills accounts for the long continuity of the wooded lines of land, an unusual fact considering the size of the islands. The amount of fresh water obtained from springs is also uncommon. (xii, 48.) The wear from storms would also be greater on islands which have been elevated.

m. Radack, Ralick and Caroline Islands.—No evidences of elevation in these groups are yet known. The very small amount of wooded land on the Pescadores inclines us to suspect rather a subsidence than an elevation; and the same fact might be gathered with regard to some of the islands south, from the charts of Kotzebue and Kruesenstern.

n. Ladrones.—The seventeen islands which constitute this group, may all have undergone elevations within a recent period, but owing to the absence of coral from the northern, we have evidence only with regard to the more southern.

Guam, according to Quoy and Gaymard, has coral rock upon its hills more than *six hundred* feet (one hundred toises) above the sea.

Rota, the next island north, afforded these authors similar facts, indicating the same amount of elevation.

o. Pelews and neighboring Islands.—The island *Feis*, three hundred miles southwest of Guam, is stated by Darwin, on the authority of Lutke, to be of coral, and *ninety* feet high. *Mackenzie* Island, seventy-five miles south of Feis, is a low atoll, as ascertained by the Expedition. No evidences of elevation are known to occur at the Pelews.

Melanesian Islands.—Among the New Hebrides, New Caledonia, Salomon Islands, the evidences of elevation have not yet been examined.

The details given on the preceding pages are presented in a tabular form on the next page.

		FEET.
Paumotu Archipelago,	Honden,	1½ or 2
“ “	Clermont Tonnere,	2
“ “	Nairsa or Deans's,	6
“ “	Elizabeth,	80
“ “	Metia or Aurora,	250
“ “	Ducie's,	1 or 2
Tahitian Group,	Tahiti,	0?
“ “	Bolabola,	?
Hervey and Rurutu Groups,	Atiu,	12?
“ “ “ “	Mauke,	somewhat elevated.
“ “ “ “	Mitiaro,	“ “
“ “ “ “	Mangaia,	300
“ “ “ “	Rurutu,	150
“ “ “ “	Remaining Islands,	0?
North of the Tahitian,	Washington Island,	2 or 3
“ “ “ “	Christmas,	2?
“ “ “ “	Malden,	?
“ “ “ “	Jarvis,	6 or 8?
Tongan Group,	Eua,	300?
“ “	Tongatabu,	60
“ “	Namuka and the Hapai,	25
“ “	Vavau,	100
Savage Island,		100
Samoan Islands,		0
North of Samoa,	Swain's,	3 to 6
“ “ “	Fakaafo, or Bowditch,	3
“ “ “	Oatafu, or Duke of York's,	2 or 3
“ “ “	Enderby's,	2?
“ “ “	Gardner, Hull, Sidney, Newmarket,	0?
Feejee Islands,	Viti Levu and Vanua Levu, Ovalau,	5 or 6
	Eastern Islands,	0?
North of Feejees,	Horne, Wallis, Ellice, Depeyster,	0?
Sandwich Islands,	Kauai,	1 or 2
“ “	Oahu,	25 or 30
“ “	Molokai,	300
“ “	Maui,	12—
Tarawan Islands,	Taputeouea,	1 or 2
“ “	Nanouki, Kuria, Maiana and Tarawa,	2 or more.
“ “	Apamama,	5
“ “	Apia or Charlotte,	6 or 7
“ “	Maraki,	2 or 3
“ “	Makin,	0
Carolines,		none ascertained.
Ladrones,	Guam,	600
“	Rota,	600
Feis,		90
Pelews,		0?
New Hebrides, New Caledonia,	Salomon Islands,	none ascertained.

Several deductions are at once obvious:—

1. That the elevations have taken place in all parts of the ocean.

2. That they have in some instances affected single islands, and not those adjoining.

3. That the amount is often very unequal in adjacent islands.

4. That in a few instances the change has been experienced by a whole group or chain of islands. The Tarawan Group is an instance, and the rise appears to increase from the southernmost island to Apia, and then to diminish again to the other extremity.

The Feejees may be an example of a rise at the west side of a group, and possibly a subsidence on the east; while a little farther east, the Tonga Islands constitute another extended area of elevation. We observe that while the Samoan Islands afford no evidences of elevation, the Tonga Islands on the south have been raised, and also the Fakaafo Group and others on the north.

We cannot, therefore, distinguish any evidence that a general rise is or has been in progress; yet some large areas appear to have been simultaneously affected, although the action has often been isolated. Metia and Elizabeth Island may have risen abruptly: but the changes of level in the Feejees and the Friendly Islands, appear to have taken place by a gradual action.

Art. XX.—*On Soleil's Saccharimeter;* by W. P. Riddell, A.B., New Orleans, Louisiana.

This instrument, so beautiful in theory, and so exact in its practical operations for the analysis of *sugars*, *syrups* and *molasses*, depends upon that peculiar property of light termed *circular polarization;* a modification first noticed by M. Arago in crystal quartz or rock crystal.*

Polarization.—The Newtonian theory of the *materiality* of light fails to give an adequate explanation of the phenomena of polarization. But, according to the *wave* or *undulatory* theory, common light is considered an *effect*, produced by the vibrations of an extremely subtile medium, termed *luminiferous ether.* These vibrations are supposed to be in three directions, in rectilinear and rectangular planes; two of which are transverse to the direction in which the ray is propagated and at right angles to each other; and the third, parallel to the direction of propagation. The existence of this third plane is inferred from the phenomenon of the dispersion of the different rays of the spectrum. But of this we need not speak particularly, as it has no essential bearing on the present subject.

Leaving out of view then this third plane, we see that we may consider common or unpolarized light to be produced by vibrations in two rectangular planes. Now if we can contrive to separate these two vibrations so as to have two rays, each being produced by vibrations in one plane only, we shall have two rays of *polarized* light, whose planes of vibration are perpendicular to each other. If again we bring these two sets of vibra-

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* It might seem unnecessary to enter at all into the subject of polarization, as nothing new is offered; yet to render the following application plain, to those who have given the matter no previous study, it was thought best to offer a succinct view of the received notions respecting it.

tions *centrally* together, without changing their planes, we have, as before, *one* ray of unpolarized light, produced by vibrations in *two* rectangular planes. Thus we have a distinct idea of the difference between *polarized* and *unpolarized* light.

There are several ways in which we may thus separate these two planes and hence produce polarization: viz, by simple reflection at certain angles (differing for different substances); by single refraction, as by means of a bundle of thin glass plates; by double refraction, as by means of a crystal of Iceland or calc spar; by transmitting a ray through a plate of tourmaline, which has the property of smothering or absorbing the vibrations in one direction and permitting only those of the other plane to pass through.

Circular polarization is a condition slightly different from the above, and is produced only when rectilinear vibrations are made to interfere with each other in a particular manner: this interference does not take place when both sets of vibrations have equal velocities. But as we know that if one wave of water be half an undulation behind another of equal size, they mutually destroy each other; while the same, if of equal velocities, may vibrate in vertical, right angled planes, with no sensible interference; so may we conjecture in regard to these waves of light-bearing ether.

It may be shown in various ways, that the result of the interference of these rectilinear vibrations will be curvilinear vibrations, a movement which may be likened to "that of the extremity of the swinging pendulum," or more aptly to the spiral course of a coiled wire. If then we can *retard* the vibrations in one direction, then bring them centrally in contact with those of the other direction, they mutually interfere, and no longer, as in the case of simply polarized light, produce common light; they no longer vibrate in rectilinear planes, but in a curvilinear plane, the *result* of the two forces acting in the original rectilinear planes. By varying the amount of this retardation, we may produce *circular* or even *elliptical* waves. If this retardation amount to the one-fourth of an undulation, the waves will be circular, as can be shown by means of a very simple apparatus devised by Professor Wheatstone.

It is found that crystal quartz possesses in a high degree this power of retarding one of the two sets of vibrations; thus affording, in connection with light properly polarized, *circular polarization*. Some species of quartz exhibit what is termed right-handed polarization, hence called *dextrogyrate;* some, left-handed polarization, hence called *lævogyrate;* the distinction between which being as follows:

If we place a plate of Iceland spar, cut perpendicular to its principal or prismatic axis, in the polariscope, the polarizing and analyzing plates being crossed, we shall observe a gorgeous display of colored concentric rings intersected by a rectangular black cross, whose arms meet at the centre of the rings. In these rings we observe a succession of the seven colors of the spectrum; and some very singular changes, which need not here be described, take place when we revolve either the polarizer or analyzer. All the modifications which light undergoes in passing through certain crystals, may usually be traced to the peculiar structure or crystallization of said crystal; but quartz, which is classed in the same system of crystals with Iceland spar, gives us quite a different result when placed in the polariscope. We observe a system of prismatic rings, but the black cross in the centre is not there, and in its place we have a certain uniform tint the hue of which changes successively through the whole range of the spectrum, when either the analyzer or polarizer is revolved; for right-handed quartz, if we revolve the analyzer to the right, the colors will be seen to succeed each other in the following order: *red, orange, yellow, green, blue, indigo, violet, red*, and so on; while for the left-handed quartz they will be seen to succeed each other in the contrary order, viz.: *red, violet, indigo, blue, green, yellow, orange, red*, and so on; hence to obtain the same order of succession as in the first case we must revolve the analyzer in the opposite direction, or to the left. Therefore the first kind of quartz is called *dextrogyrate*, the second *lævogyrate*. The width of this central hue, as well as that of the concentric circles, will depend upon the thickness of the plate of quartz employed, the diameter of the rings being, it is said, inversely as the square root of the thickness of the film of quartz.

As circular polarization is supposed to result from two sets of rectilinear vibrations centrally joined, acting in rectangular planes one of the sets being *retarded*, so colors are supposed to result from two sets of rectilinear vibrations, one of which is retarded, but both of which act in the *same plane*.

The application of the foregoing principles for the purposes of analysis comes next to be explained. If we take two plates of tourmaline, (which by the way must be cut in planes parallel to the axis of crystallization,) place them parallel, one with its axis in a vertical, the other with its axis in a horizontal position; then permit a ray of common light to strike perpendicular upon them,—the first will stifle all except the vertical vibrations, while the second will stifle all except the horizontal ones; hence no light will be permitted to pass through both plates thus placed.

This position of the two plates of tourmaline, viz.: so as to extinguish the light, is termed the *azimuth zero*, or point of greatest obscuration. If now we place between these two plates a piece of quartz, or any other circularly polarizing substance, the effect is immediately noticed from the fact that the light which was before obscured by the two tourmaline plates is now seen to pass through the three,—and in order to reëstablish the *azimuth zero*, it is necessary to revolve the analyzer, either to the right or left as the case may be, through a certain number of degrees, according to the thickness of the interposed quartz. If instead of the plate of tourmaline, a double refractor be employed for a polarizer, a similar result is observable, except that instead of totally shutting out the light at the azimuth zero, we are only able to exclude one image, usually the *extraordinary*; and so to rëestablish the azimuth zero, we only seek to exclude one of the images, both having been rendered visible by the interposition of the quartz; this we do as in the other case, by revolving either the analyzer or polarizer. The angle through which it is necessary to revolve the analyzer has been found proportionate to the thickness of the quartz; or if two plates of quartz be interposed, the angle of variation will be as the *sum* of the two thicknesses, if both be right-handed, or both left-handed; or as the *difference*, if one be right and the other left: and the same in regard to all *circularly* polarizing substances.

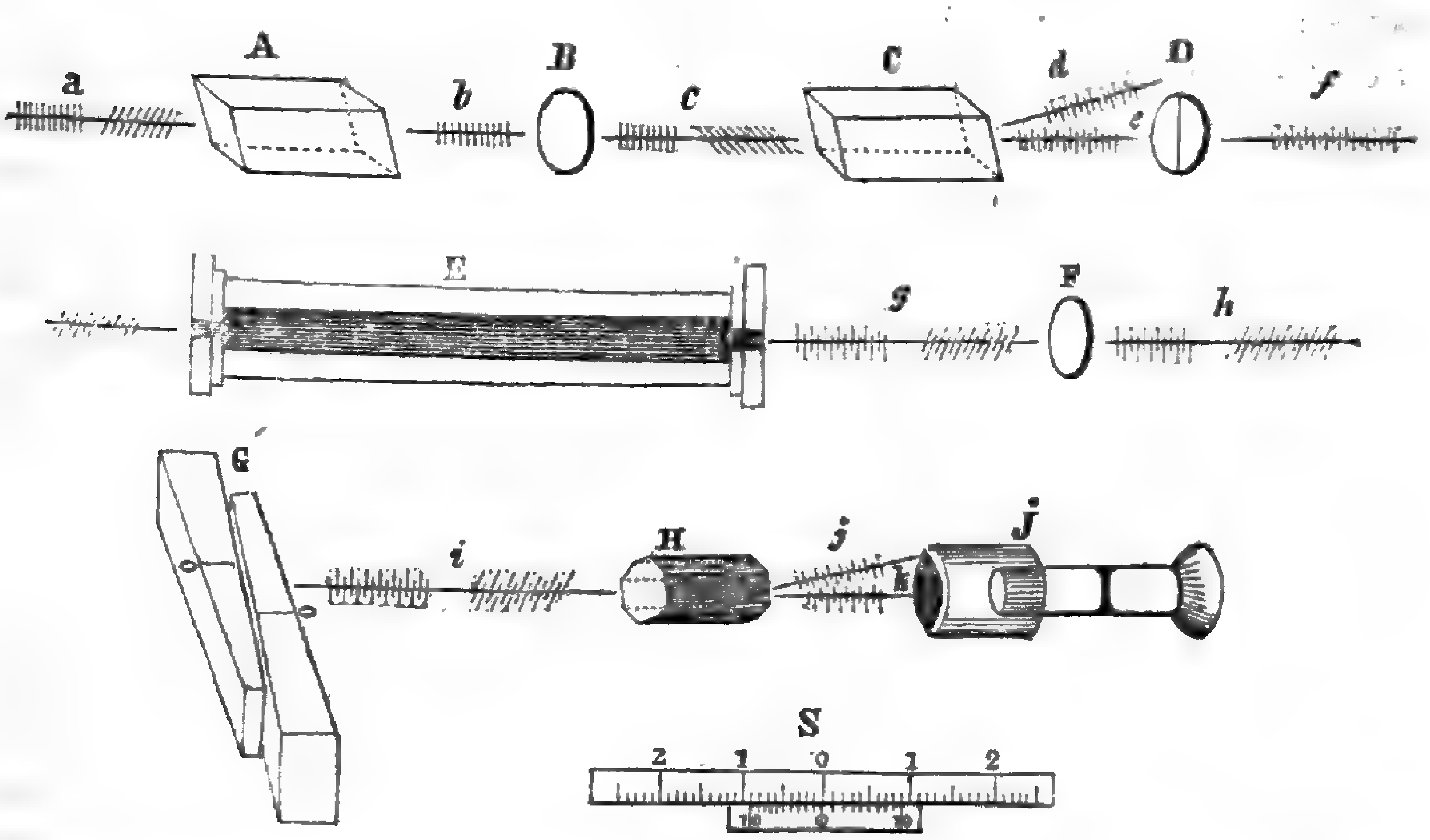
We can then at once, get a glimpse of the extended application of which this singular principle is susceptible.

In the earlier instruments constructed on this principle, for the analysis of sugars, &c., the only parts were the *polarizer*, the *tube of observation*, and the *analyzer*; and the amount of sugar was estimated from the number of degrees through which it was necessary to revolve the analyzer in order to reëstablish the *azimuth zero*; but it was found no easy matter to judge as accurately as was desirable as to this point of greatest obscuration, for the analyzer had to be revolved over several degrees before any change could be observed.

A second step was taken by substituting a ray of *homogeneous* light; but still it was found exceedingly difficult to distinguish, with a precision sufficiently constant and exact, the precise *limit* of each color; for they seem to flow so readily into each other, and besides, of themselves, have something of a margin on the spectrum. This defect is very ingeniously surmounted in the instrument of Soleil, by placing side by side two plates of quartz, one left-handed, the other right-handed; so that any difference is not only doubled, but instead of judging of the *identity* of any certain abstract hue, we have only to *identify*, by means of the compensator, the hues of two juxtaposed semi-discs.

Soleil's Saccharimeter.—We have now taken a general view of the principles on which saccharimetry, by means of circular polarization, depends. It remains briefly to speak of the instrument constructed by Soleil of Paris, (which I think undoubtedly deserves the first place,) and describe somewhat more minutely the process of actual analysis by means of it.

The instrument, of which I propose to give a very brief description, was brought from Paris by the Hon. J. P. Benjamin, of New Orleans, and now belongs to Prof. J. L. Riddell, of the University of Louisiana. It consists of the following parts, commencing at the extremity farthest from the eye of the observer when making an analysis :—



A, Polarizer, a Nicol's Prism, admitting only one of the polarized rays to pass through.

B, Depolarizer, being a plate of right-handed quartz, cut perpendicular to the axis of its crystallization.

C, the polarizer proper, or analyzer as related to A and B, whose functions are only to produce any desired tint by merely revolving; which is accomplished by means of a thumb-screw, close to the thumb-screw of the compensator.

D, Biquartz, composed of two juxtaposed plates of quartz, of equal thickness, but of contrary rotative power, one being right-handed, the other left-handed ; by which the difference observed in the tints of the semi-discs, when the right- and left-handed rotations in the instrument are not in equilibrio, are doubled, since the tints as observed through the one semi-disc succeed each other in the opposite order to what they do as seen through the other.

E, Tube of observation, 20 and 22 centimeters long, into which the liquid to be analyzed is poured, and closed by means of glass plates, which are held in their place by brass caps closely fitted, as it is very essential that every bubble of air should be excluded ; when the tube has been filled with the saccharine liquid and replaced in its proper position in the instrument, the tints of the two halves of the ordinary and extraordinary disc will be seen to be different and complementary for the reason already noticed, but can be brought to a uniform tint, as at starting, by means of the compensator; and the *direction* in which the compensator has to be moved determines the quality of rotation; the *distance* over which it has to be moved determines the quantity or amount of that rotation.

F, plate of left-handed quartz, equivalent in thickness to the two plates of the compensator, G, when set at zero; and its object is to equilibrate the opposite effect of said compensator.

G, Compensator, composed of two wedge-shaped plates of right-handed quartz, the thickness of whose *sum* may be varied by sliding their *thicker* or *thinner* extremities together; at zero their thickness is equal to that of F. If the principal part has to be moved to the right, and the vernier to the left, the specimen under examination exerts a rotary influence to the right, and is consequently *right-handed*, and *vice versa*. The scale and vernier of this compensator is shown separately at S.

H, Analyzer, being a double refracting prism.

J, Eye-piece, with two adjustable lenses, to fit the focus to different eyes. The progress of a ray of common light (*a*) striking upon A, is as follows:—By A it is polarized, so as to vibrate in only one rectilinear plane, (*b*,) as the vibrations in all other planes are smothered. By B this polarized ray (*b*) is resolved into two sets of rectangular vibrations, (*c*,) one of which is retarded: by C these again are resolved into two systems of rectilinear, rectangular vibrations, (*d* and *e*,) one set of each system being *retarded*, hence colored rays, one of which (*e*) only is received through D. By E the tint of this colored ray is changed, and must be restored by G. The effect of F and G, being equivalent, and mutually neutralizing, may be counted as nothing. By H the color of the rays is made visible, by bringing the vibrations in a position so as to interfere in the same plane, which is necessary for the production of colored light.

On the scale of the compensator, G, the figures 1 and 2 correspond to quartz of an opposite polarization, whose thickness is 1 and 2 millimetres, and are read 100 and 200 degrees. The smaller divisions are read 10 degrees each, while single degrees are read by means of the vernier. The degrees therefore correspond nearly to $\frac{1}{4}$° in the deviation of the *plane* of polarization.

Among substances which exercise an influence on the polarizing apparatus, the most important, according to Pereira, are:

Volatile oils (those of mustard and bitter almond excepted).

Naphtha.

Aqueous solutions of several kinds of *sugar*, *dextrine*, tartaric acid and tartrates (tartrate of *alumina* excepted).

Diabetic urine.

Albuminous urine.

Alcoholic solutions of *camphor* and *artificial camphor*.

Most *vegetable juices*.

While as devoid of this property, we may enumerate *water*, *alcohol*, *pyroxylic spirit*, *pyroacetic spirit*, *olive oil*, *claret wine*, (with perhaps a trace of left-handed polarization,) *champagne*, *citric acid*, *mannite*, *liquorice sugar*, *glycerine*, *&c.*

It will be seen from the above that sugars of different kinds exert different effects in connection with polarization. These effects Mr. Pereira classes as follows:

1. *Cane sugar*, ...	*Right-handed.*
2. *Grape sugar*, (Glucose of Dumas,) . .	" "
3. *Uncrystallizable sugar*, (Chulariose of Soubeiran.)	
Uncrystallizable sugar of honey, . . .	*Left-handed.*
Uncrystallizable sugar obtained by the action of acids on cane sugar, . . .	" "
Uncrystallizable sugar of the juice of fruits,	" "
Uncrystallizable sugar obtained by the alteration of cane sugar. This constitutes the greater part of molasses, . . .	" "

4. *Mannite*, 5. *Glycerin, and* 6. *Liquorice sugar*, 0 (zero).

Process of Analysis.—Make the zeros of the compensator (on the scale and on the vernier) correspond perfectly; then revolve the analyzer by means of the thumb-screw until the *semi-discs* have one and the same *uniform* tint; the two *discs* will then be observed to have complementary colors: thus, if the ordinary *disc* or *image* be *violet*, the extraordinary one will be *yellow;* if the former be red, the latter will be green, &c. The focus of the eye-piece may either be adjusted now, or after the liquor is introduced into the observation tube; this is done by adjusting the distance between the two lenses, to suit different eyes while looking through the instrument: if done before the liquor is introduced, water should be placed in the tube, because the focus will vary somewhat if the tube be empty.

For *brown sugar* and *molasses*, an analysis is effected by comparing the rotating power of a solution of known degree of dilution, with the rotating power of a standard *normal* solution. From the specimen which we wish to analyze (whether molasses or sugar) we weigh, by means of special weights accompanying Clerget's apparatus, 16·471 grammes; place this in a matrass graduated on the neck to 100 and 110 cubic centimetres: pour in water till the matrass is filled to the 100 c. c. mark. If the mixture be sufficiently transparent, submit it to *observation* in the tube of 20 centimetres length, and note the degree of *deviation* by means of the degrees marked on the compensator, in the way before described. But if not, complete the filling of the matrass to the 110 c. c. mark, by pouring in either sub-acetate of lead, or fish glue and alcohol; if the latter, first introduce 5 c. c. of a solution of fish glue, and then the other 5 c. c. of alcohol. The defecating agent must be mixed thoroughly with the liquor and allowed to stand two or three minutes, then thrown upon the filter. If now the mixture be too highly colored to admit of observation, it must be discolored by filtration through *bone-black*, or *animal charcoal;* special tubes for which are provided in Clerget's very full and beautiful set of apparatus, which usually accompanies the Saccharimeter. The process will require one hour, and possibly the liquor may have to be passed through the bone-black several times. It must be remembered however, that the first portions (a quantity about equal to the volume of bone-black) which come through the bone-black, must not be employed in the observations, as it is found that the bone-black, until a little saturated, weakens the solution. The liquor is next introduced into the tube of observation, and the rotation noted as before by turning the thumb-screw of the compensator till the two semi-discs again exhibit a uniform tint. If, previous to filtering through the bone-black, the *defecating agent* has been used, the tube of 22 centimeters must be employed to compensate for the consequent dilution; but if the defecating agent has not been used, the tube of 20 centimetres must be employed. It will be observed that using the tube of 22 centimetres is the same in effect as adding $\frac{1}{10}$th to the strength of the solution as determined in the tube of 20 centim.

The number of degrees of rotation as read on the scale of the compensator, will give the actual *per cent* of *pure* sugar in the sample. The scale is so graduated that if we had weighed 16·471 grammes of *pure sugar*, and formed our solution in the same way, by means of the matrass graduated to 100 c. c., the rotation as indicated by the degrees of the compensator, would be 100°. Hence any proportional number of degrees of rotation will indicate a corresponding proportional amount of saccharine matter as compared to pure sugar. Or, since the *normal* or *standard* solution contains 164·71 grammes of pure sugar per litre, we may multiply the number of degrees of rotation of any solution by 164·71, and divide the product by 100, and we shall obtain the number of grammes of pure sugar contained in the litre of our sample solution.

The above method is all that is necessary in solutions which contain no *left-handed* sugar, and nothing which may interfere with the legitimate action of the *right-handed* cane sugar, the determination of which is the usual object of analytical research. But since brown sugars, and especially molasses, invariably contain other substances which exert a polarizing influence sometimes to the right, sometimes to the left, it is desirable to disengage the influence of the same from the influence *due* to the *cane sugar*. For this purpose we perform what is termed the

Process of inversion, which affects the polarizing power of the cane sugar *only;* but which changes this from *right-hand* to *left-hand* sugar. It is accomplished in the following manner:

From the solution prepared, (defecated and decolorized, if necessary, as explained,) fill a small matrass to the mark on the neck indicating a capacity of 50 c. c., complete the filling of the matrass to the mark on the neck indicating a capacity of 55 c. c., by pouring in strong hydrochloric acid; place the matrass in a water bath kept uniformly at a temperature of 68° Centigrade, continue it there for 15 minutes, and the inversion will be complete. Throw this upon a paper filter, and allow the liquid to flow directly into the tube of 22 centim. length, which is provided with a special *upright* tube for determining the temperature which exerts a considerable influence on the rotatory power of inverted liquids, and must be carefully noted; it is better to make the observations at some uniform temperature, as for instance 28° or 30° Centigrade.

If the rotation be to the left, *add* it to the rotation to the right determined previous to the inversion; if the rotation be still to the right, *subtract* it from the right-handed rotation previously determined. In the table, which accompanies Clerget's apparatus, under the temperature corresponding to the temperature at which the observation after inversion has been made, seek the number corresponding to the *sum* or *difference* of the degrees of rotation determined by the observation, follow to the right hand the line of horizontal figures to the column marked A, in which will be found the figures expressing the *per cent.* by weight of sugar in the sample; or continue to the column marked B, in which will be found the figures expressing the number of grammes *per litre* contained in the given liquid. Either of these will express the *title* of sample under analysis—the former gives the title by *weight*, the latter, by *volume*.

Mr. Clerget, in his "Memoire à la Société d'Encouragement," on the analysis of sugars, &c., (where a very full description of the apparatus, &c. used in analysis is given,) recommends the following preparation of fish-glue: macerate in cold water (near 25 centiliters) for about 30 hours, 5 or 6 grammes of isinglass, or fish-glue; dilute this with one deciliter of white wine or of diluted alcohol. Treat the mixture with water till the volume amounts to one liter. Thus prepared, if preserved in a closed bottle, the liquor will remain unaltered for 15 or 20 days, according to the temperature, but it should not be used after becoming strongly acid.

Sub-acetate of lead, which on some accounts (especially for decolorizing) is superior to fish-glue, may be prepared "by digesting 7 parts of litharge with 6 of sugar of lead, and 30 of water, till the oxyd which is not dissolved, has become white."

When *bone-black* is used, its volume had best be about one-third the volume of the liquid to be decolorized, and should be moistened with the liquid before being introduced into the *filter-*

ing tube, as this greatly facilitates a speedy filtration. The same bone-black may be used several times, if care be taken to rinse and dry it after each operation. It has been found also, that its qualities may be in a great measure restored by *burning* anew.

Analysis of Canes.—From M. Clerget's memoir before mentioned, I translate, in *substance*, the following: weigh 200 grammes of the cut cane, and extract the juice therefrom by means of the small *special press*, endeavoring to make the pressure as near that exerted by the common sugar presses as possible, in order that the juice may be a fair representative of that usually extracted in the manufactories; from this juice fill the graduated matrass to the mark indicating a capacity of 100 c. c.; to this add 10 c. c. of the defecating agent as in the analysis of sugar and molasses; filter and introduce it into the tube of observation 22 centim. long: take the *degrees* of variation, which multiply by 164·71 and divide the quotient by 100 and you will have the number of grammes of *sugar* contained in a liter of the juice; the calculation may be dispensed with by referring to the number expressing degrees of deviation in the column of the table marked A, and seeking the corresponding ones of the column marked B, which will give the number of grammes per liter contained in the juice.

If now, by means of a very delicate areometer graduated to the 10th of a degree, we take the density of the liquid, we may infer from a very easy comparison between this density, the saccharimetric title of the juice and the weight of the pressed cane, the actual per cent. of the real sugar contained in the juice to the weight of the original cane: for example, a specimen of 200 grammes of Tahiti cane cultivated in the Antilles was submitted to the action of the small *presse d'essai*, and left a pulp weighing 48 grammes; it consequently produced 152 grammes of juice, of which the density was found to be 108°·5; this juice observed by means of the saccharimeter gave a deviation to the right of 124°; multiplying this number by 164·71 and dividing the product by 100, the quantity of sugar per liter was found to be 204 gr. 24 c., which is the *title* which we also find in the column B, opposite 124° in the column A. Then we have 1085 (weight of a litre of the juice) : 204·24 (weight of the sugar per litre) : : 1 : 0·1882 (the per cent. of the sugar compared to the juice):—and 0·1882 multiplied by 152 we obtain the total quantity of the sugar extracted by simple pressure from the 200 grs. of the cane, that is, 28 gr. 60 c., or 14·30 per cent. of the weight of the cane.

In the analysis of fresh cane juice, it is not usually necessary to perform the operation of inversion—a process which must not be omitted in the examination of molasses and impure brown sugars.

General Remarks.—Professor McCulloh, in his Report to the government, gives 52 per cent. as the average amount of crystallizable sugar contained in West India and Louisiana molasses examined by him. Biot and Soubeiran place the average of their analyses of molasses as low as 40 p. c.; while Ventzke estimates the same at 60 p. c. Much may be attributed to the different circumstances, &c. under which the analyses were made. McCulloh asserts that a saturated solution at 212° Fah., will contain 80 p. c. of cane sugar, 50 of which will crystallize.

The matter has excited considerable interest on the part of the government from the fact that it has been said, that nearly pure *syrups* have been imported by refiners under the name of molasses; and that the resulting refined sugars have been exported under the privilege of the *drawback.* These syrups (*sirops de batterie*) contain, according to McCulloh, 60 p. c. of cane sugar, and may be so disguised as to render it difficult to distinguish them from molasses.

I examined with the instrument before mentioned, several samples of molasses imported from the West Indies, which Dr. E. H. Barton, Inspector of drugs and chemicals, brought from the custom house, with the following results:

Sample A = 50°·6. Right-handed polarization previous to inversion.
= 15°· (at temp. 30° C.) Left-handed " after "
Consequent title, 51 per cent.

Sample B = 44°· R. polarization previous to inversion.
10°· L. " (at temp. 28°) after inversion.
Consequent title, 42 per cent.

Sample C = 46°·2. R. P.
24°· L. P. (at temp. 30°.)
Consequent title, 54·5 per cent.

Sample D = 62°·7. R. P.
20°· L. P. (at temp. 30°.)
Consequent title, 64 per cent.

Sample E = 51°·7. R. P.
20°· L. P. (at temp. 30°.)
Consequent title, 53 per cent.

Sample F = 49°·5. R. P.
10°· L. P. (at temp. 26°.)
Consequent title, 45 per cent.

It has been inferred from experiments by Henry and others, that *cane sugar* is the primary secretion of the plant, and that the grape sugar and uncrystallizable sugar contained in molasses is the result of fermentation, decomposition consequent on ill-management in the manufactories. The former, or cane sugar proper, is termed by Dr. Cartwright the *worm-destroying* sugar, while the latter he terms *worm-producing;* having reference to their medicinal properties.

McCulloh gives 18 per cent. as the proportional amount of cane sugar which he obtained by an analysis of the ripe cane juice, but remarks that it is probable that 21 per cent., as obtained by Péligot and Casaseca, may be the usual or average proportion, since his analysis was made of a particular and unfavorable specimen.

He gives the following as the result of his *comparative analysis of the three varieties of cane:*

	Tahiti.	Creole.	Ribbon.
Water, - -	68·20	68·76	71·45
Solid matter, -	31·80	31·24	28·55
	100·00	100·00	100·00

The proportional yield of sugar from the same he rates respectively at 67·884, 62·918 and 63·68.

In using the saccharimeter of M. Soleil, (or indeed any depending on polarization,) some difficulty may be experienced in properly decolorizing the liquor, which must be quite clear and *transparent* in order to admit of accurate observation. Good bone-black at times is very essential. But when once in proper order, there can be no doubt as to the general accuracy of its saccharimetric determinations.

"The programme of a *prize* offered by the Société d'Encouragement called for a process which should determine, *within two per* cent., the richness of saccharine substances. The process of M. Soleil is much more exact."

Art. XXI.—*Observations on some Mounds on the Tensaw River;* by A. Bigelow, Wesleyan Institute, Newark, N. J.

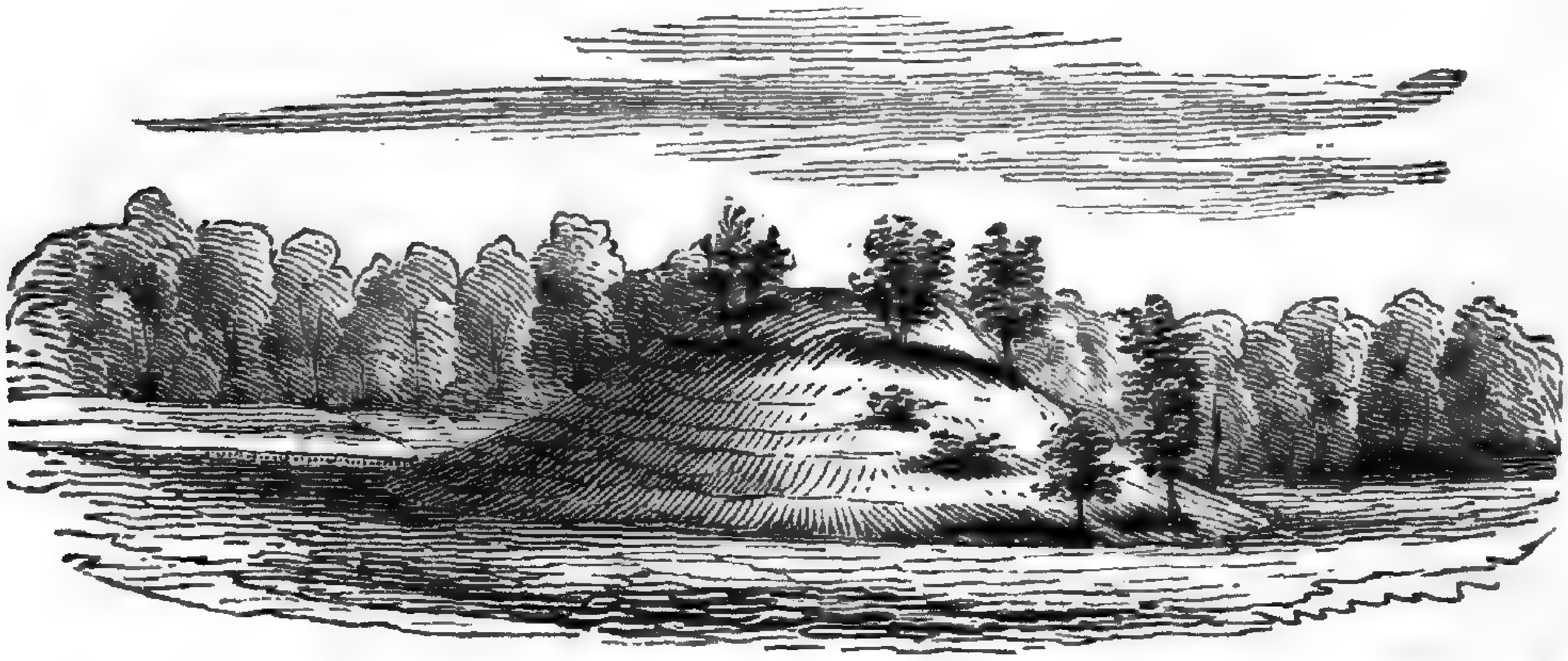
During a two years residence near Hall's Landing on the Tensaw river, I heard frequent reports of some mounds upon it, about twelve miles to the north, and was induced to visit them at two different times. The first impressions more than realized my expectations, and the examination was one of interest.

About twenty miles north of Mobile, the Tensaw separates from the Mobile river, running to the east by a very tortuous course as far as Stockton, then to the south, emptying into the east side of Mobile bay. Between these two rivers is enclosed a tract of land, twenty miles long and about seven wide, consisting of marsh and swamp land. Much of it is impassable; some of it quakes and sinks beneath the tread, and is covered with tall grass and aquatic plants; the larger portion supports heavy forests, and is called swamp land. Only small portions of the whole tract are dry even in dry weather, or elevated above the spring floods.

North of the Tensaw, land of a similar character extends for ten miles. The tract between the two rivers is intersected by several creeks and rivers; Middle river, which is wide and deep, flows out of the Tensaw soon after the latter leaves the Mobile, and running southeast, empties again into the Tensaw; thus cutting off a triangular portion from the northeast corner of the tract. Again, Bottle creek leaves the Tensaw not far to the east of Middle river, and running south or west of south, empties into Middle river. In this latter triangular piece, are the mounds. This area is also intersected by the Dominique creek, which runs near to the west side of the mound field, and with which the mounds are connected by a series of small mounds now concealed by the forest. Along with these creeks and rivers are numerous lakes or lagoons, which are affected by the tides, and contain an abundance of fish; indeed the waters teem with them, to an extent which surprises one accustomed to throw the line in clearer streams. Among the inhabitants of these waters, the alligator is not the least abundant, and in a young state, it is yet used occasionally for food, as it appears to have been by the former dwellers upon these banks.

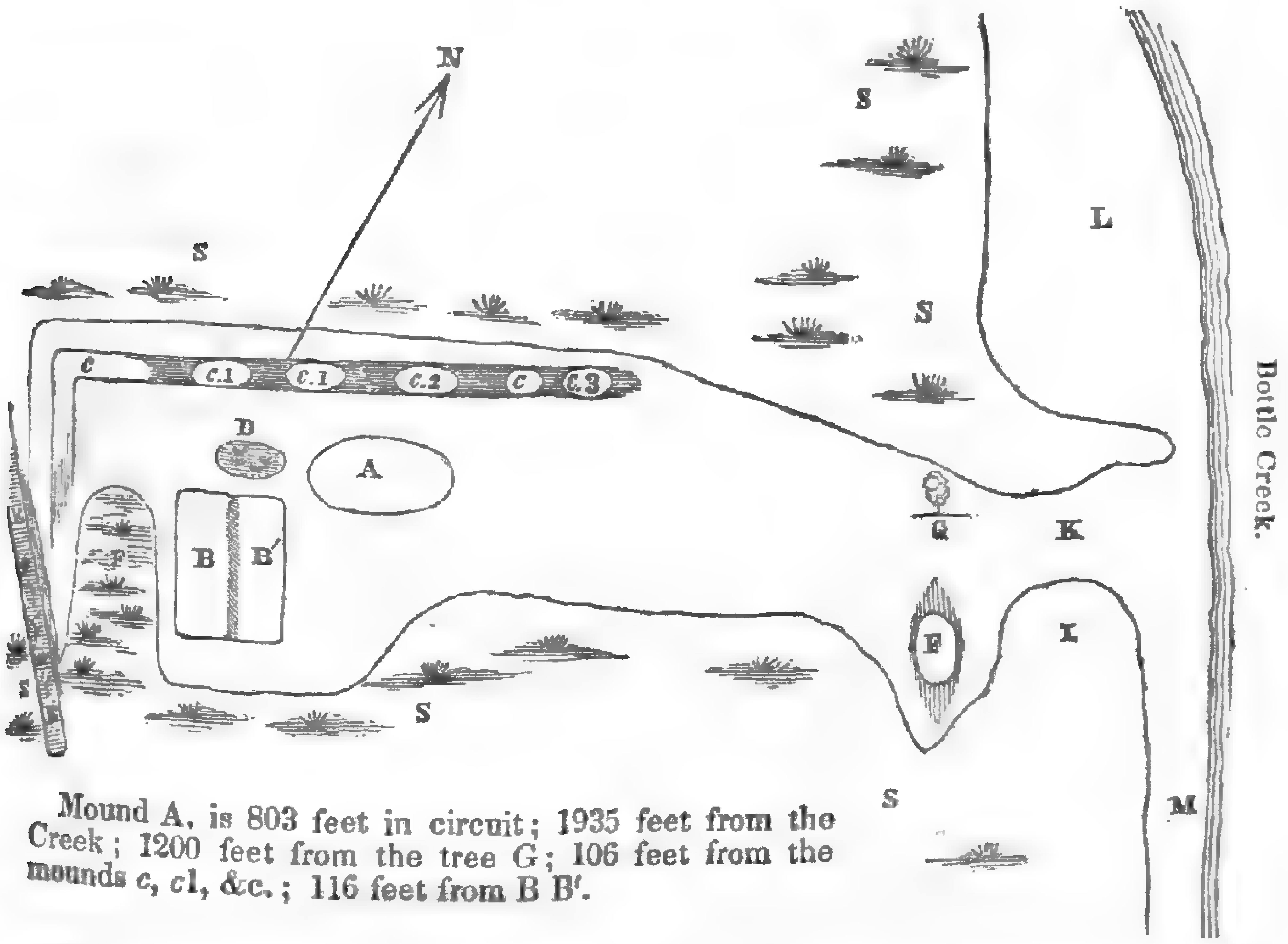
On the west side of Bottle creek, where it leaves the Tensaw, is probably the most elevated portion of the land above described. Here the first inhabitants found sufficient room and material to construct these mounds; and the French a plantation ready for seed. This locality was early settled, and has been cultivated ever since, receiving from the yearly overflow an addition to its fertility. The Gnathodon beds described by Rev. S. C. Hale in this Journal for March, 1851, occur frequently around the head of the bay, but I know of none on Bottle creek; and indeed the Gnathodon shell is but sparsely intermixed in any of the mounds. As low down as within ten miles of the bay, I have seen mounds raised on the banks of existing creeks and near the beds of former ones, with few shells intermixed with the earth. In such cases they look like small portions of levees, elevated just above the high floods. They contain no perceptible relics of former life; and appear to me to have been thrown up, as places of security against high water, by some former people, if not for constant use, at least for a summer residence, for the convenience of obtaining food. To a people unaccustomed or unwilling to till the soil, there existed an unfailing source of food, of a kind which is even now much used by the creoles and negroes living there. The abundance of food and the facility of obtaining it, the convenience of communication by the various creeks, isolation from disturbing tribes, healthiness of the locality,—for the French even went from Mobile to their swamp plantations in summer,—and the mildness of the winter, would induce a tribe to make this region their permanent abode. There is nothing to disprove such a supposition, except the danger and inconvenience of the floods. Against these the mounds are a security; and, in one case a raised ridge is now used as the site of some buildings. On the Gnathodon beds and the mounds hereafter to be described, relics are often found, the most important of which are images. One bust of a person was discovered near the bay, which very strikingly exhibits the Indian features, and also considerable skill on the part of the sculptor; for these images appear to have been first moulded, and then cut out by some edged instrument. I would here remark that the floods occur at irregular times, usually from February to May, but often in June and July, and occasionally in August.

1.



The plantation before spoken of, lies on the Tensaw and Bottle creek, and has a crescent shape; at its southern extremity the eye is attracted through an opening in the forest, by an elevated mound nearly in the center of a large field, the appearance of which as thus seen, is represented in figure 1. This mound is now oval, but has the appearance of having been somewhat rectangular when built. It is a striking object in the landscape, both from its size and elevation. It has a wide base and gradually tapers to the summit, which is 104 feet long by 46 feet wide and elevated about 49 feet above the river at mean tide. The mound stands on ground a little below the surface of the river banks; its sides are covered with trees 40 feet high, and with shrubs and a few palmetto bushes. It has been frequently cultivated in corn, and as its sides have been worked with the plough and hoe, as well as furrowed and washed with rains, we may suppose, that it has been thereby changed in figure and elevation. Near to this is a large rectangular mound of small elevation, one-half its breadth, about five feet higher than the other, and about six feet above high water. On the north and west side of these is a series of low mounds, so connected as to form a ridge of raised earth, extending along one side of a rectangle and part of another till it ends near the swamp. The diameters of the high mound lie in the same directions with the sides of the other mounds; and the whole arrangement is so regular and nearly rectangular, as to induce one to suppose it laid out by a compass. But I think it to have been done by the eye, according to the position of the ground and river. Its position as respects the compass on the north side is E. by N. E., but it is parallel with the river and general direction of the sides of the field. The entrance looks directly upon the large mound and fronts the whole arrangement. A swamp covered with forests surrounds the whole except the entrance from the river.

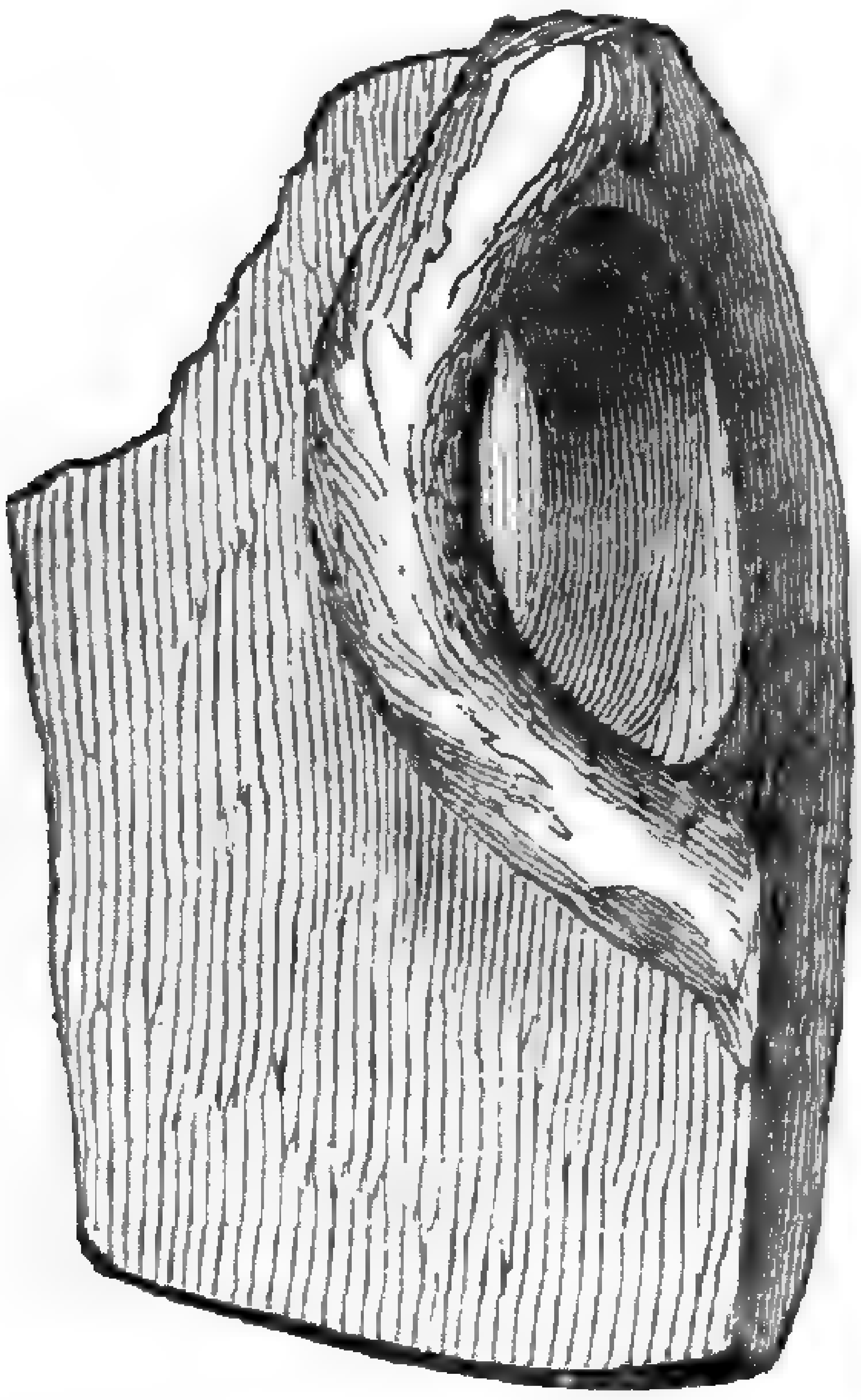
2.—PLAN OF THE MOUNDS AND FIELD.



Mound A, is 803 feet in circuit; 1935 feet from the Creek; 1200 feet from the tree G; 106 feet from the mounds *c*, *c*1, &c.; 116 feet from B B′.

For a more particular description the reader is referred to fig. 2. Bottle Creek is represented on the east side; L is a part of the plantation extending to the Tensaw; S S, the swamp which surrounds the whole; K, the entrance to the mound field. On the left is a small mound F, in which were found the bones of an Indian, together with a large collection of beads and other articles usually attending an Indian interment. The beads are globular, three-quarters of an inch in diameter, having a large hole for the string; they are of glass, translucent, and of a bluish color. *c*, *c*1, *c*2, and *c*3, form the portion of a rectangle outside of the larger mounds: *c*3, and the one next to it are much used now for stacking hay to prevent injury by the floods; the others are not quite so high. On *c*1 and *c*2 many images, beads, and pieces of copper have been found, having been turned up by the plough. Upon *c*2 I found an old fire-hearth a short distance below the surface, and beside it the bones of various animals now existing there. Those of the alligator were most abundant. B B′ is the large rectangular mound; B is about five feet higher than the part B′; it is 344 feet long by 250 wide. I think, from its situation and appearance that the builders designed to bring up the whole to the same elevation, so as to have more room and greater security. Upon this are found great quantities of broken crockery, which evince considerable skill in modelling and finishing. Some of the ware must have been very large, and all of it is covered on the inside and outside with a thin coat of a finer quality, which answers the purpose of glazing. Some of the fragments have ears so similar to those used on our iron and eathenware as to induce the belief that the later Indian workers of this ware copied from those on the utensils of the Spaniards when among them. One of these forms, represented in fig. 3, is suitable for receiving a bail; fig. 4 is attached to the side of the upper edge, for conveniently lifting and carrying by the

3.



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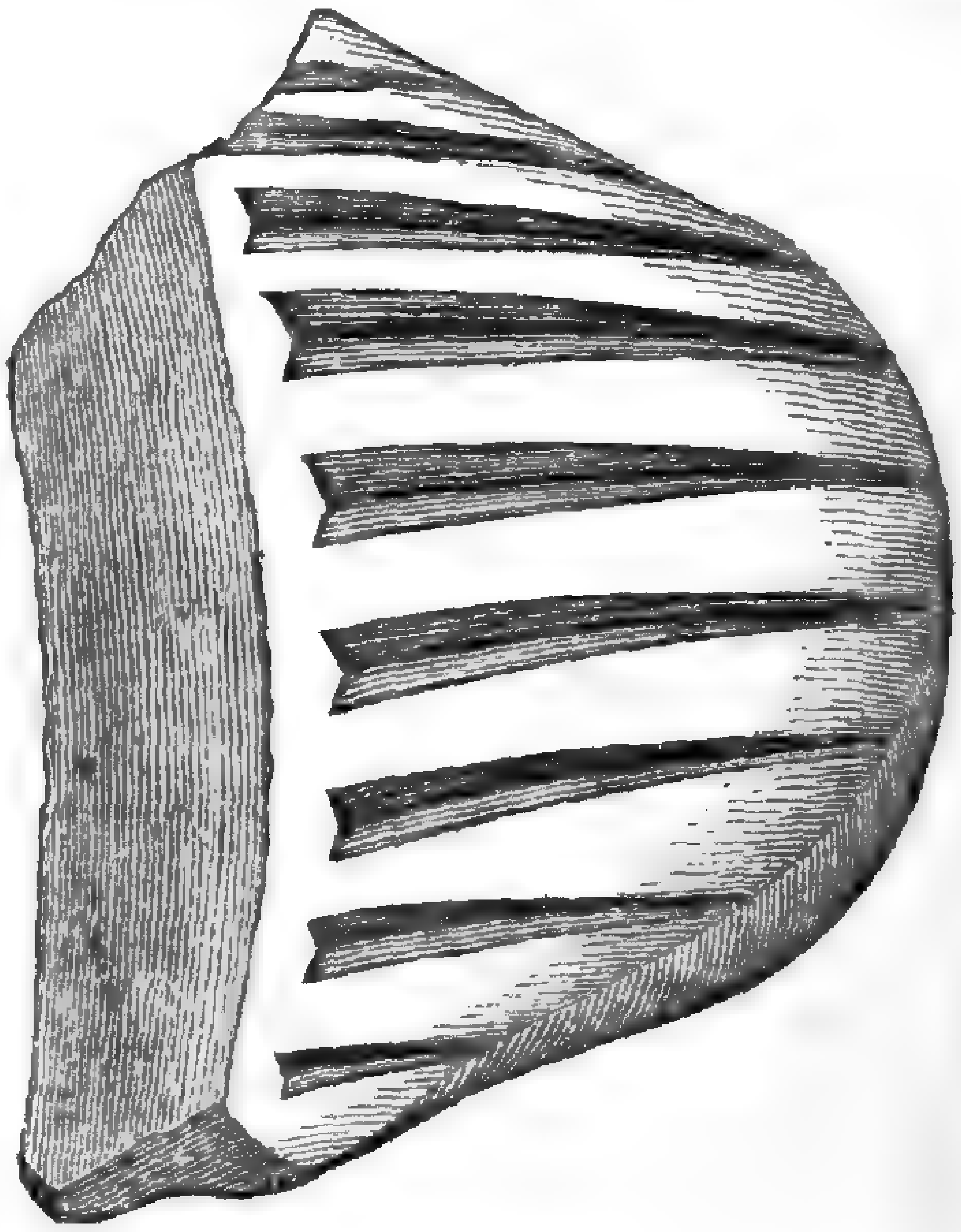

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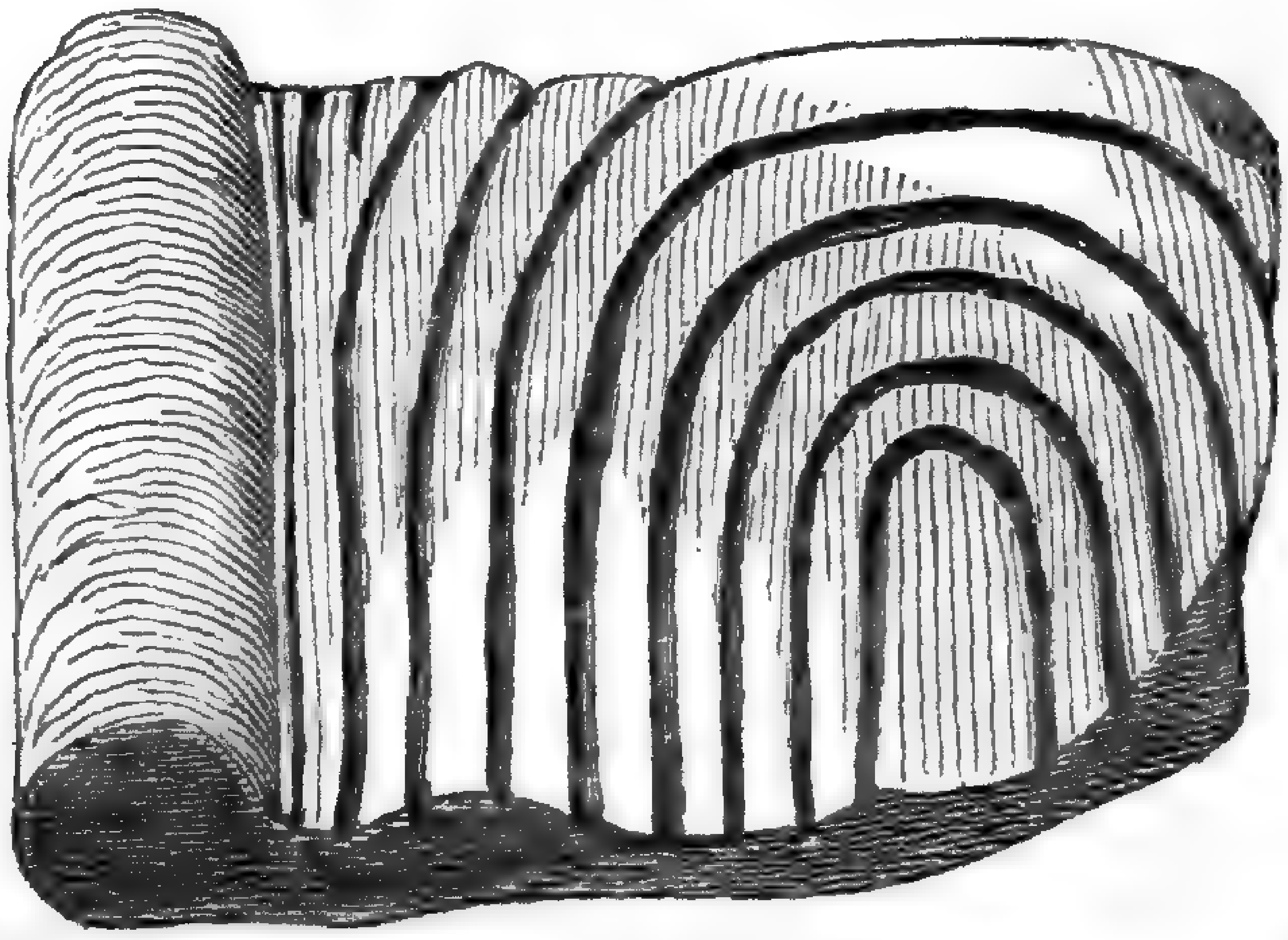

hands; the upper surface is ornamented with parallel grooves. Nearly all the fragments are ornamented with rude devices, cut in the outercoating by a sharp point. One of these devices is represented in fig. 5, and also the rim of the vessel is shown upon the same fragment. The ware is made of clay of different qualities, and comminuted shells; and is of different shades from a light gray to a black. Their images were made of a purer clay, having a light gray color after baking, but were evidently worked with some tool to the proper form before baking. The image of a man in a sitting posture and so constructed as to form a pipe, the smoke issuing by small holes from the mouth and nose, was found here.

D, in fig. 2, is an excavation of some depth, containing water in which some trees are now growing. It appears by its position, to have been designed as a water hole, or well. It is also an excavation from which material was probably taken for the mound B. A is the large mound occupying the center and overlooking all. E E is a ditch beginning a little south of the mound B B′ and extending northwest nearly to Dominique creek. It contains water and trees, being in the edge of the swamp, and has the appearance of an ancient canal. It is sufficiently long to have afforded nearly all the material for the mounds, and may have been used as a way of approach from the northwest. As before remarked, this system of mounds continues across this ditch towards middle river. I will here state that in digging into these mounds I found an entire absence of stratification, but a mingling of small masses of mud and loam as if promiscuously thrown together. Very few shells are on them or beneath the surface; I found a few Gnathodon and oyster shells.

The trees in the surrounding swamp are comparatively young, and there is no appearance of a former growth. The newer part of this alluvial tract is an open marsh, sinking under the feet, and there is every reason to suppose that this was the character of the whole region when these mounds were built. In that case, a view of a wide region could be had from the high mound, and every approach observed. If the forest then existed, I do not see how the ditch E E could have been excavated with rude tools. It also seems to me that the mounds could not have been built at a remote period, as we may believe that it is not very long since the ground became tenable for such a purpose. Hence towards the head of the bay on this alluvial tract no mounds of note are observable between the rivers, but in the hammock, a higher and firmer land on the east side of the Tensaw five miles above the bay, are some large rectangular mounds, and also some ridges extending from a creek to the river. These show greater age, since very large trees are growing upon them. Their height is not over five or six feet.

These facts, the temptation to a savage people to dwell in the midst of so much food, the necessity of protection against the floods, and the absence so far of great antiquity, lead me to attribute these works to some tribe of the present race of Indians. One examination remains to determine this matter in my opinion, that is, a section cut through the mound A. If no evidences can be found within it of a more ancient people, then the conclusion to which I have come must seem reasonable. I cannot, however, see why our aboriginal Indians should construct so high a mound as A, unless for defense in case of attack. I was told by the negroes who worked the mound when planted, that they had found the stumps of an old stockade. It may easily be conceived that it was a stronghold and a lookout over the then open marsh. It is supposed that the first engagement which De Soto had with the Alabama Indians, was at Choctaw Bluffs, and that thence he led his army across the ford of the Tensaw at this plantation, and from this place passed on westward across the Mobile; and that at no other point could such a passage have been made. Many Spanish relics have been found, such as carbine barrels, rings of brass, pieces of copper ornaments, and swords. One of the latter was nearly entire, having on one side of the hilt an embossed likeness of Ferdinand and on the other of Isabella. The Tensaw Indians at one time probably occupied these regions, but at an early day left for the west, and till the close of the war of 1812, the Creeks claimed all east of the Tensaw river as their hunting ground. These tribes, within the memory of the present inhabitants of Baldwin county, used earthern vessels similar to those above described, for culinary and other purposes.

The localities described above are not the only ones where proofs of former occupation are found. From near Stockton a wide and high road is traced into the swamp nearly in the direction of the mounds we have been describing, covered with large trees. While we wonder at the taste which led any people to locate themselves on these marshes, we wonder equally at the evidences of a rather numerous population, which are presented as we paddle in a light pirogue along the creeks and into the lakes of the region.

Art. XXII.—*On the Phosphorescence of some Marine Invertebrata;* by M. A. De Quatrefages.*

I. *Historical review of the subject.*

1. *Causes of phosphorescence.*—It is well known that the waters of the sea, in some latitudes and under certain circumstances, are phosphorescent, producing a light more or less brilliant. This remarkable phenomenon has always attracted the attention of travellers, and various have been the explanations they have offered. Without going here into useless detail, we will first mention those hypotheses which are now completely set aside, before dwelling on better founded opinions.

Ancient navigators seem to have indicated a resemblance between the light produced on the surface of the water and that which is due to atmospheric phenomena, by designating the former "meteors of the sea." Something of this idea is evident even in the writings of learned men, who endeavored to explain this phosphorescence solely by physical or chemical causes. Thus Nollet could see in it only a simple modification of electrical phenomena. Bajon, in his memoirs on the History of Cayenne, regards this light as due to the electricity of the waves, developed by the force of opposing currents or by the prows of vessels. Other authors have attributed it to phosphoric fires, to the burning of bubbles of hydrogen which rise to the surface to explode, &c. &c. The opinion published by Tingry is of a similar nature. This philosopher regards the phosphorescence of the sea as analogous to that which certain bodies, the diamond in particular, present, after having been a while exposed to the sun. Without entirely setting aside the agency of animals, he attributes the greater part of the phenomenon to a sort of previous imbibition of the sun's rays, which are thrown out again during the night. He thus explains entirely by physical causes the remarkable intensity of this phosphorescence in tropical seas.†

A more rational if not a more correct explanation, at least for many cases, is that which attributes the phosphorescence of the sea to the decomposition of fishes and other marine animals. This opinion was adopted by Commerson in his manuscripts which are deposited in the Library of the Museum.

A passage very much to the point is quoted by Lesson from one of his manuscripts.‡ "Phosphorescence is owing to a general cause, that of the decomposition of animal substances, espe-

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* From the Annales des Sci. Naturelles, vol. liv, 3d series.

† De la phosphorescence des corps, et particulièrement de celle des eaux de la mer (Journal de Physique, t. xlvii).

‡ Dict. des Sc. Nat., article, Phosphorescence.

cially of whales and seals, which abound in oily matters." Bory de St. Vincent, Oken, and others have adopted the same view. There is certainly great appearance of probability in this explanation, it is sustained by well known facts and sufficiently accounts for certain circumstances of the phenomenon. Still in many cases it is scarcely better founded than the preceding. The same appears to have been the opinion of Newland, and of those who like him have attributed phosphorescence to the spawn of fishes.

But, since the beginning of the last century, careful observations have been made; and various observers have found that a great number of sea animals have the property of directly emitting this light. Since 1805, Viviani, professor of natural history at Genoa, has discovered in the neighborhood of that city, and described in a work on the subject, fourteen species of phosphorescent animals.*

Many travellers have noticed the phosphorescent properties of the Medusæ. Spallanzani, by diffusing in milk the mucus from their bodies, rendered the liquid luminous.† Vianelli attributed the phosphorescence of the sea to a Nereis; Shaw, to certain flexible zoophytes, &c.

French naturalists have not been behind in this movement. In 1764, Rigaut discovered and described in an unmistakable manner the Noctiluca of Suriray; it is to them that he attributes the phosphorescence of the British Channel and Atlantic Ocean. The Abbé Dicquemare, by researches in the harbor of Havre confirmed the first results, which, forgotten for a time, were again corroborated by the labors of Suriray at the same locality. The learned hydrographical engineer, M. de Tessan, rediscovered the Noctilucæ, or animals very similar, in the seas of the Cape of Good Hope, at False Bay.‡ M. Rang mentions their presence on the coast of Algiers.§ More recently M. Verhaeghe has been led by his investigations at Ostend‖ to the same conclusions as Dicquemare and Suriray.

The assertion of Rigaut was manifestly exaggerated; the Noctilucæ are not alone in producing this phenomenon. The luminous properties of various Medusæ have been established beyond doubt by the testimony of Peron, Macartney, Tilesius, Banks, Forskal, Humboldt, Ehrenberg, Rathke, etc. Peron and Lesueur, Humboldt and others after them, have described with en-

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* Phosphorescencia maris quatuordecim lucescentium animalculorum novis speciebus illustrata. Genuæ, 1807.

† Voyage en Sicile.

‡ Comptes Rendus de l'Académie des Sciences, 1840. Rapport fait par M. Arago.

§ Cited from Gervais, by M. Van Beneden.

‖ Report of M. Van Beneden on the menoir of Dr. Verhaeghe, entitled, Recherches sur la cause de la phosphorescence de la mer dans les parages d'Ostende (Bulletin de l'Académie royale de Belgique, t. xiii, Part ii, p. 8, 1846.)

thusiasm the magnificent spectacle presented by shoals of Pyrosomas, which in the dark look like streams of fused metal. Henderson ascribed the light of the gulf of Guinea principally to the Scyllari and to Salpas.* Certain Acalephs, Mollusca, Crustacea, Annelids, Rotatoria, Lumbrici, Turbellariæ, Echinoderms, Zoophytes and Infusoria have been successively pointed out as capable of phosphorescence; and if we do not here go into more detail on this point, it is because the subject has been so fully treated by Ehrenberg. In the work which the illustrious Secretary of the Berlin Academy has devoted to the phosphorescence of the sea, he has enumerated 450 authors who have treated more or less fully of the production of light by organized beings; and to this memoir we refer those readers who are curious to understand thoroughly the history of the question.† We annex a table, cited almost entire from M. Van Beneden, in which are enumerated the various species of invertebrate animals whose phosphorescence has been established.

INSECTS.

G. Lampyris.—L. noctiluca, L. splendidula, L. italica, L. ignita, L. phosphorea, L. nitidula, L. lucida, L. hemiptera, L. japonica.

G. Elater.—E. noctilucus, F. ignitus, E. phosphoreus, E. lampadion, E. retrospiciens, E. lucidulus, E. lucernula, E. speculator, E. janus, E. pyrophanus, E. luminosus, E. lucens, E. extinctus, E. cucujus, E. lucifer.

G. Buprestis.—B. ocellata.

G. Chiroscelis.—C. bifenestrata.

G. Scarabeus.—S. phosphoricus.

G. Pausus.—P. sphærocerus.

G. Fulgor.—F. laternaria, F. serrata, F. pyrrhorhynchus, F. candelaria.

G. Pyralis.—P. minor.

G. Achita.—A. gryllotalpa?

MYRIAPODA.

G. Scolopendra.—S. electrica, S. phosphorea, S. morsitans.

G. Julus.

CRUSTACEA.

G. Carcinium.—C. opalinum.

G. Erythrocephalus.—E. macropthalmus.

G. Scyllarus.—Espèce indéterminée.

G. Gammarus.—G. pulex.

G. Cyclops.—C. brevicornis.

G. Oniscus.—O. fulgens.

ANNELIDA.

G. Nereis.—N. mucronata, N. noctiluca, N. phosphorans.

G. Syllis.—S. fulgurans.

G. Photocharis.—P. cirrhigera.

G. Polynoe.—P. fulgurans.

G. Chætopterus.—C. pergamentaceus.

G. Lumbricus.—L. phosphoreus.

G. Planaria.—P. retusa.

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* Cited by M. Van Beneden.

† Das Leuchten des Meeres (Abhandl. der Kœnigl. Akademie der Wiss. zu Berlin, 1834).

MOLLUSCA.

G. Helix.—H. noctiluca.
G. Pholas.—P. dactylus.
G. Pyrosoma.—P. atlanticum, P. giganteum.
G. Phallusia.—P. intestinalis.
G. Salpa.—S. zonaria, S. Tilesii.

ECHINODERMATA.

G. Asterias?
G. Ophiura.—O. telactes, O. phosphorea.

ACALEPHA.

G. Pelagia.—P. phosphorea, P. noctiluca.
G. Oceania.—O. Blumenbachii, O. pileata, O. hemispherica (Thaumantias), O. lenticula, O. microscopica, O. scintillans.
G. Beroe.—B. fulgens, B. rufescens.
G. Cydipe.—C. pileus.
G. Mnemia.—M. Norwegica.

POLYPI.

G. Pennatula.—P. phosphorea, P. grisea, P. rubra, P. argentea.
G. Veretillum?
G. Gorgonia?
G. Sertularia?
G. Alcyonia?

INFUSORIA.

G. Ceratium.—C. tripos, C. fusus.
G. Peridinium.—P. Michaelis, P. acuminatum, P. furca.
G. Prorocentrum.—P. micans.
G. Stentor?
G. Synchæta.—S. baltica.
G. Noctiluca.—N. miliaris.

We believe that the above list is far from complete, at least as regards marine animals. Our own observations enable us to add at least two species of Polynöe, one species of Syllis, some species of allied genera, and one or two of Ophiura.*

II. *On the mode of producing light by Marine Invertebrata.*

Almost all researches undertaken to discover the manner of producing light in animals, have been made on insects, especially the Lampyri and Elaters. Spallanzani, Burmeister, but above all, Macaire,† have published results apparently decisive. These

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* In the above list of phosphorescent Crustacea, *Oniscus fulgens* is a *Sapphirina;* and the *Carcinium* probably belongs to the same genus (see this Journ., [2], ix, 133). *Regulus, Euphausia* and *Cypridina* are other phosphorescent genera, as observed by the writer; and also Lucifer according to Thompson, (Zool. Researches, p. 58,) and Thysanopoda, *Edw.* Cypridina is evidently the genus of the species referred to by Reville as observed to be phosphorescent on a voyage to India, (Mem. de l'Acad. des Sci., Savans Etrangers, iii, 267, and Thompson's Zool. Res., p. 41.)

Scyllarus must be incorrectly added to the list, as there are no oceanic species of the genus. The error is moreover evident from the fact that the reference of the phosphorescent Crustacea to this genus, was made before the species were well understood. Captain Tuckey who states the facts, in his voyage to the Congo has the words, "with little Crustaceous animals of the Scyllarus Genus (attached to them [Salpæ]),"—evidently inconsistent with the genus Scyllarus, which includes large species of very different habits. The term was probably meant for *Squilla,* and the species may have been Schizopods of the family Euphausidæ.—J. D. D.

† Journal de Physique, t. xciii.

experiments undertaken and varied by Matteucci,* with all the precautions furnished by experimental science at the present day, leave, we think, no room for doubt. In the insect which he examined, the light was produced by an actual slow combustion analogous to that of phosphorus exposed to the air. This light is extinguished in a vacuum and in the irrespirable gases; it reappears by contact with atmospheric air; it is sensibly brightened in pure oxygen; it continues in animals after they are dead, or even cut to pieces. The particular substance from which it emanates may be isolated, and may leave upon the fingers or the dissecting instrument a luminous streak which disappears only on drying; a little dampness even, in certain cases, is sufficient to restore the phosphorescence; finally, the production of this light is accompanied in the living animal, as well as in its dead carcass, by the escape of carbonic acid. Everything concurs then to show that the phosphorescence of insects, and probably of all aerial animals, is owing to a peculiar secretion, whose substance combining slowly with oxygen produces light.

But can this explanation of phosphorescence be applied to invertebrated animals living in water? Such questions immediately arise but yet have been overlooked by most naturalists. The greater part of the observers from whose works we have cited have been satisfied with knowing that animals produced the phosphorescence of the sea; some have gone a little farther and have attributed this phenomenon to the secretion of a luminous liquid. This opinion appears generally adopted, and traces of it may be seen even in the writings of some naturalists who have not formally stated it. The experiments of Spallanzani and the observations of many travellers seem fully to confirm this view, which is evidently correct in some cases. Dugés, for instance, has decidedly adopted it, and has implied a resemblance between the phosphorescence of the Medusæ and Annelids, &c., and that of the Elaters and Lampyrides.†

A very different opinion has been set forth by M. Gilbert, an officer of the corps of naval engineers, who without being aware of the investigations of others on this subject, had seen the Noctilucæ and describes them rather coarsely but in a manner easily recognized. He explains the production of light in these animals by the development of electricity from the surface of their bodies, a development brought out by the action of the waves.‡ This explanation is evidently untenable even in a merely physical point of view.

Lesson appears to us one of the first, if not the first, who has seen in phosphorescence a phenomenon distinct from the physico-

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* Leçon sur les phénomènes physiques des corps vivants, 8e leçon.

† Traité de physiologie comparée. t. ii. Montpellier, 1838.

‡ Annales maritimes, 1817.

chemical actions which take place in our laboratories, but without explaining himself very fully on this subject. This naturalist regards phosphorescence as due to Crustacea belonging to different genera; he allows that the seat of this light, emitted on irritation or at the time of procreation, resides in glands placed in a variable number on the sides of the thorax. He adds: "this light should be regarded, as a fact established by investigation, as a modification of the laws of life, and as different from the simple sparkling light resulting from the decomposition of animal substances.*

Carus, losing sight of the philosophy which prevails in his works, adopts the opinion that this phenomenon is a property of *primary animal matter*, which is nothing else than the nervous substance and which representing the solar element in the animal, necessarily appears luminous to the planetary element.† He then, as well as Oken, from whom he cites the passage, "regards the jelly of Zoophytes, Medusæ, &c., as the nervous substance in its lowest stage, from which the other substances embraced within it have not been isolated."

M. Bérard, cited by Duges,‡ regards the phosphorescence of animals as due to a kind of luminous imbibition, or purely vital effect, analogous to those which result in different bodies, from the action of heat, electricity, light, &c.

Dr. Coldstream published in Todd's Encyclopedia a very interesting article on phosphorescence.§ After having examined the nature of animal light, the natural or artificial circumstances which influence its appearance or intensity, the points of body in different animals from which it is produced, he sums up all that we have learned from different authors of the phosphorescent organs, and the different theories proposed to explain these phenomena. We quote from this English author some passages from this part of his work.

According to Beccaria, Meyen, &c., the phosphorescence of animals is owing to what they absorb from the rays of the sun, which they throw out again in the dark.

Spallanzani regards phosphorescence as a kind of combustion sustained by the oxygen of the air.

According to Brugnatelli, the light is taken in with the food, and disengaged by particular organs.

Macaire considers the phosphorescent matter as composed of phosphorus and albumen. The variations of intensity apparent in the light arise more or less from the coagulation of the albu-

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* Dict. des Sc. Natur., 1826, article Phosphorescence.

† Traité élémentaire d'anatomie comparée, traduit par Jourdan, t. i.

‡ Traité de physiologie comparée, t. ii.

§ The Cyclopedia of anatomy and physiology, Part xxii, article Animal luminousness, 1841.

men, a coagulation which is increased or diminished at the will of the animal, and permits a more or less rapid combustion.

Tiedemann, Darwin, H. Davy, Heinrich, Treviranus, Burmeister, &c., believe in the secretion of a liquid containing phosphorus, and in the combustion owing to the air introduced by respiration.

Macartney and Todd regard phosphorescence as due to the nervous fluid concentrated and modified by certain organs, so as to appear under the form of light.

The author next proposes his own theory founded on a sort of fusion between the two preceding. With Macartney, he admits that phosphorescence is due to an imponderable agent, and compares it to the production of electricity by certain fishes. But considering the well known fact of the luminous traces that certain animals leave behind them, he supposes that phosphorus or an analogous substance may very well enter into the composition of the organs which produce the light.

It is plain that Dr. Coldstream, in common with all the authors whom we have cited, believed that phosphorescence should be attributed to but one cause.

This error M. Becquerel* has avoided. After having shown that in the Lampyris and other insects, phosphorescence is the result of a chemical action at the control of the animal, M. Becquerel relates the observations of Ehrenberg, and admits with him that in certain inferior animals the production of light is owing to a disengagement of electricity. Moreover, he recalls the observations of MM. Quoy and Gaimard, who had seen under the equator, near the island of Rawak, small zoophytes, which while swimming rapidly, drew after them luminous trains. Finally, M. Becquerel, resting on this fact, and on his own observations made in company with M. Breschet, at Venice, in the waters of the Brenta, allows that the phosphorescence of the sea may be owing to an organic substance intimately combined or mingled with the water, analogous to that which covers the herring and other fish when they are phosphorescent.

Doctor Coldstream seems not to have known of two memoirs which appeared in Germany, about the same time, and which we have reserved for the close of this history, on account of their peculiar interest.

The first of these works is that of M. Ehrenberg,† and it is incontestibly the most complete which has been published on this subject. To all the facts made known by his predecessors, the author adds the result of his own investigations in many seas. At Alexandria he established beyond doubt the fact that the

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* Traité de physique comparée, dans ses rapports avec la chimie et les sciences naturelles, t. ii, 1844.

† Loc. Cit.

Spongodium vermiculare, as also other Algæ regarded as phosphorescent, owe this appearance only to the luminous animalcules adhering to their surface. He describes a new species of Polynöe (*P. fulgurans*) found by him in the Baltic, that apparently plays an important part in the phosphorescence of that sea, which also owes its luminous properties to different infusoria. At Christiana and at Helgoland, Ehrenberg observed this phenomenon in many species of Medusæ; at the last locality he met with the *Noctiluca miliaris*, which he calls Mammaria. Ehrenberg describes also the very remarkable mode of phosphorescence which appeared in a Nereid, the *Photocharis cirrhigera*. In that Annelid, the light proceeds from two thick and fleshy cirri belonging to the dorsal branch of the feet. The author observed sparks, at first isolated, invade the cirri by degrees, until they became luminous in their whole extent; then the phosphorescence spread through the whole back, until the animal looked like a thread of burning sulphur. The mucus secreted by the Photocharis left on the fingers a luminous trace. In the *Polynöe fulgurans*, Ehrenberg regards two large rough bodies, resembling ovaries, as charged with producing the light. In the *Cydipe pileus*, and in the *Oceania pileata*, he found that the light starts from the centre, that is, in the neighborhood of the reproducing organs. In the *Oceania hemispherica*, a species whose diameter is more than an inch, Ehrenberg saw the sparks from a chaplet around the border; these correspond to the large cirri or to the organs alternating with them.

Ehrenberg sums up in the following manner the important results of his labors:

1st. The phosphorescence of the sea appears to be owing solely to organized beings.

2d. A very great number of organic and inorganic bodies shine in the water, and out of the water in different ways.

3d. There is also a light from organized bodies which is probably owing to vital action.

4th. The active organic light shows itself frequently under the form of a simple flash, repeated from time to time, spontaneous or provoked. Often also it appears under the form of repeated sparks, following each other in quick successions, under the influence of the will, and very similar to electric sparks. Often, but not always, there is formed by this production of sparks, a mucilaginous humor, gelatinous or aqueous, which is diffused around in great abundance, and is evidently placed in a secondary or passive state of phosphorescence, which continues a long time without requiring any new influence from the organic being, and even lasts after that has been divided or destroyed.

A light which to the naked eye appears uniform and tranquil, shows itself scintillating under the microscope.

5th. The viscous humor which envelops and penetrates the ovaries seems to be especially susceptible of acquiring this communicated light, which is constantly reinforced by friction, and reappears even when it seems to have ceased.

May not the light emitted by living fishes, by Actinias, and by many other animals covered with mucosity, be sometimes merely communicated?

6th. The relations which exist between the production of light and the sexual functions are evident in the Coleoptera, although the connection of the small luminous sacs with the reproductive organs may remain concealed. With many marine hermaphrodite animals, phosphorescence appears to be a means of defence and protection, analogous to those of another kind which exist in the *Brachinus crepitans*, the cuttle fish, the frog, or to the discharges of the torpedo. Whatever it may be, the air and the sea have their phosphorescence.

7th. As yet it is only among the Annelids, and of them only in the Photocharis that a peculiar phosphorescent organ has been discovered; it is external, tufted, frequently giving out light, similar to a thick cirrus, showing a largely cellular structure, and formed within of a mucilaginous substance. The expanded base of the marginal cirri in the Thaumantias (Acalephs) may be regarded as phosphorescent organs, of an unusual kind. The ovaries are more probably luminous, passively and in a secondary manner, although their minuteness and transparency have prevented our ascertaining whether the organs of phosphorescence are placed near them; as for instance in the *Polynöe* and *Pyrosomas.*

8th. The production of light is evidently a vital act very similar to the development of electricity, an act which being completely individual, becomes more feeble and ceases on too frequent repetition, which reappears after a short interval of repose, to the production of which absolute integrity of the organism is not necessary, but which sometimes manifests direct connections only with the nervous system.

The memoir of Meyen is less extended, but it contains some important facts.[*] The author admits three kinds of phosphorescence. 1. The phenomenon is owing to a mucosity diffused in water. In that case the water seen in the day has a uniform tint of bluish white. It is often observed in tropical ports, but rarely out on the open sea. This mode of phosphorescence may be produced artificially by washing or by crushing certain Molluses and Acalephs either in sea-water or in fresh. 2. Phosphorescence results from the presence of certain living animals, endowed with a luminous mucus. This continues even after the

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[*] Beitraege zur Zoologie, von F. J. F. Meyen, fünfte Abhandlung. Uber das Leuchten des Meeres (Nov. act. nat. cur., t. xvi, suppl., 1834).

death of the animal; it arises from a superficial oxydation of the mucous coating, and it can be reproduced after it seems extinct by passing the finger over the animal. The animals which owe their luminous property to a secretion are, according to the author, Infusoria, Rotifera, Biphoræ, Medusæ, Astoria, Cuttle fish, Sertulariæ, Pennatulæ, Planariæ, Crustacea, and Annelids. 3. The third cause of phosphorescence is in some animals from the presence of one or more special organs. Of this number are the Pyrosoma, and especially P. Alatantica, whose light of a greenish blue is very brilliant. Each individual carries behind its mouth a soft opaque substance, of a reddish brown color. This body is slightly conical, and under the microscope thirty or forty red points may be seen; it is this substance which produces the light.

III. *Observations.*

It is apparent from the foregoing statements that the great majority of naturalists, whatever explanation they have given of the phosphorescent phenomena, have applied that explanation indiscriminately to all cases. Meyen himself, while admitting three kinds of phosphorescence, nowhere expresses the idea that the production of light arises from causes essentially different.

It is in this point, I believe, that the writings of these learned men are deficient. In a note published in 1843, and inserted in this Journal,* I endeavored to establish a different opinion, and to show, that under the general name of phosphorescence, phenomena essentially distinct have been confounded, and which have really nothing in common but the production of light. We have already shown that such is also the opinion of M. Becquerel. After having reviewed all that my predecessors have written on the subject; after having made new experiments and new observations, I am more than ever persuaded that it is really so. Without speaking of the phosphorescence arising from animal decomposition, nor of that which results from mucus in a state of solution, I believe that light is produced in living animals in two ways:

1st. By the secretion of a peculiar substance exuding either from the entire body, or from a special organ. It is probable that in this first mode of phosphorescence, the light always arises from a slow combustion. The fact is proved as regards insects, but direct experiments are necessary before the same certainty can exist as to marine Invertebrata, Annelids, Molluscs or Radiata.

2d. By a vital action, whence results the production of a pure light independent of all material secretion. I had arrived at this result at the time of the publication of my first note. My ob-

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* Note sur un nouveau mode de phosphorescence observè chez quelques Annélides et Ophiures, (Ann. des Sc. Nat., 2^{e} séries, t. xix, p. 183.)

servations accord entirely with those that Ehrenberg made before me; yet doubts have been thrown out on the legitimacy of conclusions which we had both considered warranted by facts furnished by observation alone. I hope that the experiments which form the subject of the latter part of this memoir will reply to all these objections.

When I published my first note, I was informed of Ehrenberg's results only through a conversation with Humboldt. I have since consulted his memoir, and find that on some points we agree entirely, while we differ on others.

With Ehrenberg I had learned to see in the phosphorescence of the Annelids and Ophiura which I have examined, an action essentially vital; but I cannot regard this action as strictly confined, either to the organs or the functions of generation, as the learned naturalist of Berlin considers it. I find, it is true, in reviewing my notes, that one of the Polynöe which best exhibited the phosphorescence was filled with Zoospermes in full maturity, but many other Annelids among those which I have studied were not in that state. Even in admitting that the light may be most brilliant at the period of gestation, I should regard that fact as merely a coincidence arising from the increase of vital energy which is thus very plainly manifested by all these animals. Besides, in the Ophiura, the independence of the light and the generative organs is very evident, since the sparks are seen only along the arms, and the reproductive organs are enclosed in the body, whose walls are very thick.

M. Ehrenberg first made known the fact that the phosphorescence of Annelids, etc., always results from a combination of microscopic sparks. Here my observations accord entirely with his. We have compared these little flashes to those which are produced from a 'tableau fulminant' which has been charged from an electrical machine.

But M. Ehrenberg has described in the Polynöe a special organ for producing this light. Here we differ. In the Polynöe as in the Syllæ and the other little Nereids which have been the subject of my investigations, I have never perceived any peculiar organ from which the light appeared to emanate. The muscles alone, and particularly the muscles of the feet, have appeared to me to present this phenomenon. I have seen moreover, some Syllæ for instance, shine through the whole extent of their bodies; and in this case the comparison to a thread of burning sulphur is striking and just. This is the appearance to the naked eye; but under the magnifying glass, this thread is divided into a double range of luminous points corresponding to the feet.

I am far from denying that certain animals may have organs charged with secreting light as certain fishes possess those for secreting electricity; but up to this time I have never seen that sparkling light show itself except in the muscles and at the moment of contraction. There may, undoubtedly, exist on this point, reasonable uncertainty with regard to those Annelids whose foot muscles are lodged in the abdomen; but this cannot be true with respect to the Ophiura, and nothing is easier than to prove this even to the unaided vision, as in the latter the phosphorescence appears along the arm and only during movement. Moreover, the details which will be given beyond of the phosphorescence of the Noctilucæ will show plainly, I believe, that these animals have no special organ for producing the light.

Finally, the Photocharis observed by Ehrenberg secreted a liquid which left luminous traces on the objects which came in contact with it. This peculiarity I have also met with in one of my Annelids; but generally in the latter and especially also in the Ophiura, the light was owing entirely to the scintillations and disappeared with them. It is however easy to believe that the modes of phosphorescence which we have admitted may coexist in the same animal.

(*To be continued.*)

Art. XXIII.—*On the question whether Temperature determines the Distribution of Marine Species of Animals in Depth*; by James D. Dana.

It is a question of much interest, how far temperature influences the range of zoological species in depth. From a survey of the facts relating to coral-zoophytes, the author arrived at the conclusion that this cause is of but secondary importance.* After determining the limiting temperature bounding the coral-reef seas, and ascertaining the distribution of reefs, it was easy to compare this temperature with that of the greatest depths at which the proper reef corals occur. This depth is but 100 feet. Now the limiting temperature, 68°, is reached under the equator at a depth of 500 feet, and under the parallel of 10° at a depth of at least 300 feet. There must therefore be some other cause besides temperature; and this may be amount of pressure, of light, or of atmospheric air dissolved in the waters.

Prof. Forbes has remarked that the deep sea species in the Ægean have a boreal character;† and Lieut. Spratt has ascertained the temperatures at different depths,‡ and shown that the deep sea species are those which have the widest range of distribution, most of them occurring north about the British shores, or

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* Exped. Report on Zoophytes, 1846, p. 103; and on Geology, p. 97; this Jour., [2], xii, 180.

† Report on the Ægean Invertebrata, Rep. Brit. Assoc., 1843, 130.

‡ Rep. Brit. Assoc., 1848, 81.

north of France. Yet is it true that the species which occur in deep water in the Ægean are found in shallow waters of like temperature about the more northern coasts? If so, Lieut. Spratt's conclusion, that temperature is the principal influence which governs the distribution of marine fauna in depth as well as in latitudinal distribution, will stand as true. But we believe that facts do not bear out this conclusion. Deep sea species live in deep seas in both regions, with but little difference in the depth to which they extend. They are boreal in character, when of Mediterranean origin, because they are cold water species; and their wide distribution is because of the wide range of temperature for which they are fitted, rather than their fitness to endure a given temperature which they find at considerable depths to the south, and near the surface to the north.

As this point is one of much importance, we have run over the recent tables of dredging, by Prof. E. Forbes, in the Ægean and about the British Islands,* to see how far it is borne out; and we add other results by R. MacAndrew, Esq., at Vigo Bay, Portugal, Gibraltar, Malta and Pantellaria, Algiers and Tunis.†

	North Scotland and Shetlands.	S'th England and I. of Man.	Vigo Bay.	Gibraltar.	Ægean.	Malta and Pantellaria.	Algiers and Tunis.
Corbula nucleus, ...	3–80	5–50	5–25	8–20	7–80	6–50	8; 35
Neæra cuspidata, ...	10–80	50	20	45‡	12–185	....	
Thracia phaseolina, ...	0–80?	3–30	....	....	7–30	....	
Solen pellucidus, ...	7–100	5–50	....	40	.....	....	35
Psammobia ferroensis, .	3–90	5–50	....	8‡	20–40	....	10
Tellina donacina, ...	1–80	5–40	....	....	7–45	....	10
Mactra subtruncata, ...	0–12	0–20?	5–10	....	.....	....	6
Lutraria elliptica, ...	0–10	0–20	low wat'r	....	.....	....	
Cytherea chione, ...	....	10–20?	....	8	7–10	6–15	
Venus ovata, ...	5–100	7–50	8	6–40	29–135	6–40	6–35
Venus fasciata, ...	5–90	7–50	8	8	27–40	6–50	6–35
Venus verrucosa, ...	....	0–10	5	6	2–40	6–15	6
Artemis lincta, ...	0–80	5–50	low wat'r	6	.....	6–15	6–8
Cardium echinatum, ...	5–100?	5–50	littoral.	....	7–50	....	
Lucina flexuosa, ...	3–100	5–50	4	....	7–11	....	
Lucina spinifera, ...	10–100	15–30?	10–12	15–25	4–30	6–40	35
Kellia suborbicularis, ..	0–90	10–40	8	....	29–45	35–50	
Modiola tulipa, ...	10–50	5–25	12	10–25	2–50	....	35
Modiola barbata, ...	....	2–15	....	....	7–95	6–15	6–8
Arca tetragona, ...	10–60	20–30	8‡	30	20–80	35–50	35
Arca lactea, ...	....	10–50	....	12–20	0–150	....	6–35
Pectunculus glycimeris,	5–80	5–50	8–12	30	6–24	....	35
Nucula nitida, ...	5–60	5–30	20–25	12–40	.....	6–15	6–8
Nucula nucleus, ...	5–100	5–50	5–25	6–20	2–10	6–40	6–35
Lima subauriculata, ...	4–100	15–30	....	35	15–30	....	35
Pecten similis, ...	2–80	20–50	20‡	....	27–185	....	35
Pecten maximus, ...	2–40	10–30	8	4–25	.....	35–50	6–8
Pecten opercularis, ...	2–100	5–50	8–20	20–40	10–70	....	35
Pecten varius, ...	3–20	3–30	8	8	7–55	6–15	35
Anomia ephipphium, ..	0–80	0–50	10	....	20–40	35–50	6–35

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* Rep. Brit. Assoc., 1843; and on British Marine Zoology, ibid. 1850, 192.

† Rep. Brit. Assoc., 1850, p. 264.

‡ Not found living at the depth stated.

The great care and thoroughness of Prof. Forbes's researches, and those also of MacAndrew, give peculiar weight to the conclusions. Those species are taken from the tables which are common to these several regions, and with regard to which the observations are free from doubt; and we have confined the list to the *Acephalous Molluscs*; as these appear to be sufficient to test the law under discussion. The depth is given in *fathoms.*

It should be observed, that, to carry out the theory, the species should be confined to *shallower* waters to the north than to the south.

To compare fairly this table, it should be noted that the dredging at the Shetlands, Orkneys, and north of Scotland, was carried to a greater depth than about southern England, fifty fathoms being the limit in the latter region, as the waters are shallow. Making this allowance, we are still struck with the *great depth* to which the species penetrate at the most northern locality, instead of the *small* depth. Out of the 21 species which are here mentioned as occurring in northern Scotland or the Shetlands, and the Ægean, 14 or 15 descend to a *greater* depth in the former than in the latter; and nearly all the species common to the north and south extremities of the British Islands, are reported from the deepest waters at the north. Of the observations made at Vigo Bay, Malta, Pantellaria, Tunis, Algiers and Gibraltar, there is but a single example among the above species of a greater range in depth than occurs in the northernmost locality examined. The dredging in the Mediterranean by McAndrew, was not carried to as great depths; yet even allowing for this, the facts are not a little remarkable.

Now the temperature in the Ægean during the warmer months, according to Lieut. Spratt, is as follows. At the surface 76° to 84°.

10 fathoms, seldom below 74° in the summer.
20 " " " 68° " " "
35 " " " 62° " " "
75 " " " 56° " " "
100 to 300 " " " 55 to 55½° "

The temperature of the waters near Southern England in summer is 62°; and near the Shetlands 55° or less. Consequently the surface summer temperature of the British Channel is not found in the Ægean at a less depth than 35 fathoms, and the *surface summer temperature of the Shetland's is the temperature at one to three hundred fathoms in the Ægean*; and still species that range to a depth of 100 fathoms about northern Scotland are found within 30 fathoms of the surface in the Ægean, that is where the summer temperature is 74° or more. Such facts show the hardiness of the species in enduring great ranges in temperature. We must therefore conclude that it is not temperature alone or mainly which determines the *depth* to which species may live. It exerts an influence, and species fitted for cold waters may be found in the deeper seas where such waters occur. But the limit of descent depends on other influences.

Looking at this table in another way, we see, as recognized by Prof. Forbes, that species which occur at or near the surface in Northern Scotland, are generally met with only at greater depths in the Mediterranean; that is, the minimum depth is less in the former case than the latter. Thus *Corbula nucleus* has for its minimum depth in the Mediterranean six fathoms, and in the northern regions three fathoms. *Psammobia ferroensis* has ten fathoms for the former, and three for the latter. Other examples will be found in the above table, sufficient to illustrate the principle although many exceptions exist. Thus species that have a range of 100 fathoms beyond Scotland may have the same in the Mediterranean, except that in many cases they do not reach as near the surface, where the waters are warm.

The Crustacea of the same seas illustrate this subject in a similar way. But the observations upon them have been made with less thoroughness and we have therefore confined our discussions to Mollusks.

Art. XXIV.—*Reëxamination of American Minerals:* Part 1st. —*Emerylite; Euphyllite; Litchfield Mica; Unionite; Kerolite; Bowenite; Williamsite; Lancasterite; Hydro-magnesite; Magnesite:* by J. Lawrence Smith, M.D., Professor of Chemistry in the University of Virginia, and George J. Brush, Ph. B., Assistant to the Chemical Department.

In the investigations which will be detailed, we have endeavored to clear up the doubts due to imperfect analyses and descriptions that exist respecting several American minerals. Every care has been taken to procure the best specimens, and our results have been tested by several analyses of each. We are under obligations to several mineralogists of this country who have placed their cabinets at our disposal for this investigation, and among those to whom we are more specially indebted, we take pleasure in mentioning Messrs. L. White Williams and W. W. Jeffries of Westchester, Pa., T. F. Seal of Philadelphia, and Mr. Theo. S. Gold of West Cornwall, Ct.

1. *Emerylite identical with Margarite.*

Emerylite was originally found by one of us on the emery of Asia Minor, and also on the same mineral coming from the Grecian Archipelago, Siberia, and China; it was subsequently traced by Prof. Silliman, Jr., in connection with the corundum occurring in various parts of this country. Its constant occurrence with emery and corundum (forming one of the minerals of elimination in their formation) suggested the name emerylite as most appropriate, its composition having been found to be different from that of any known mineral.

It was justly considered an interesting species, on account of its accompanying the various forms of corundum wherever observed; and it may be safely said, that no mineral has been proved to be as widely distributed in so short a time after the first announcement of its connection with the emery of Asia Minor, and the suggestion that it might be found with the corundum of other localities.

The analyses which were immediately made of this mineral by different chemists, on specimens coming from various parts of the world, showed a uniformity of composition most remarkable in a micaceous mineral, and so it was considered by a committee of the Academy of Sciences at Paris, who reported on this subject.* This fact is most clearly seen by reference to the following table of analyses made in 1850.

LOCALITIES.	$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	$\dddot{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{Mg}}$.	$\dot{\mathrm{K}}$ & $\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$	$\dot{\mathrm{Mn}}$	
Gumuch-dagh,	29·66	50·88	13·56	1·78	0·50	1·50	3·41	——	J. L. Smith
Island of Nicaria,	30·22	49·67	11·57	1·33	*trace*	2·31	5·12	——	"
" "	29·87	48·48	10·84	1·63	*trace*	2·86	4·32	——	"
Island of Naxos,	30·02	49·52	10·82	1·65	0 48	1·25	5·55	——	"
" "	28·90	48·53	11·92	0·87	not est'ed	not est'ed	5·08	——	"
" "	30·10	50·08	10·80	*not esti'ed*	"	"	4·52	——	"
Gumuch-dagh,	30·90	48·21	9·53	2 81	"	"	4·61	——	"
" "	31·93	48·80	9·41	1·50	"	2·31	3·62	*trace*	"
Siberia,	28·5	51·02	12·05	1·78	"	not est'ed	5·04	——	"
Village Green, Pa.	32·31	49·24	10·66	——	0·30	2·21	5·27	——	W. J. Craw
"	31·06	51·20	9·24	——	0·28	2·97	5·27	——	"
"	31·26	51 60	10·15	——	0·50	1·22	4·27	——	"
"	30·18	51·40	10·87	——	0·72	2·77	4·52	——	"
Buncombe Co.,N.C.	29·17	48·40	9·87	——	1·24	6·15	3·99	HF 2·03	Silliman, Jr
Unionville, Pa.,	29·99	50·57	11·31	——	0·62	2·47	5·14	——	W. J. Craw
"	32·15	54·28	11·36	*trace*	0·05	not est'ed	0·50	——	Hartshorne

It was suspected by us, at the time the species was made, that it might prove identical with margarite, but not having the latter mineral at hand, we had to proceed on the known analyses of it which we here give. The 1st is by Dumeril; the second by the Göttingen Laboratory on the authority of Hausmann.

	$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dddot{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
1.	37·00	40·50	4·50	8·96	1·24	1·00=93·20
			$\dot{\mathrm{Fe}}$		$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Mg}}$
2.	33·50	58·00	0·42	7·50	0·03	0·05=99·50

These analyses differing so materially from those of emerylite fully justified the formation of the species.

As soon as margarite could be procured, it was subjected to analysis and the inaccuracy of former analyses proved; but we

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* Comptes Rendus de l'Académie des Sciences, Oct. 28th, 1850.

had not at that time sufficient of the mineral to complete the investigation as desired. In the mean time Hermann* reanalyzed it, found a different composition from any previous one, and concurring with the one that had been made by us, as well as with those more recently made which are here given.

	$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\bar{\dddot{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\bar{\mathrm{H}}}$	
1.	28·47	50·24	1·65	11·50	0·70	1·87	*trace*	5·00	= 99·26
2.	28·64	51·66		12·25	0·68	2·01†		4·76	=100·00

These correspond to the formula

$$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+3\bar{\dddot{\mathrm{Al}}}^3\dddot{\mathrm{Si}}+3\dot{\bar{\mathrm{H}}}.$$

	Atoms.	At. weight.	Per ct.	Oxygen ratio.
Silica,	4	2309·24	30·58	4
Alumina,	6	3850·8	50·99	6
Lime,	3	1054·5	13·96	1
Water,	3	337·5	4·47	1

The specimen of margarite examined was received from Dr. Krantz of Bonn, and came from Sterzing in the Tyrol, the original locality.

By these analyses it will be seen that margarite and emerylite are identical, and the former name having priority of date (although the composition of the mineral was not made out until lately,) it must doubtless replace the latter, unless its geological appropriateness can sustain it.

2. *Euphyllite* of Silliman.

This mineral was first analyzed by Crooke, but the analysis having been made by a fusion with carbonate of baryta, was found to be incorrect. It was reanalyzed by Erni and Garrett.‡ Dr. Erni's analyses gave the formula, $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+11\dot{\mathrm{R}}\dddot{\mathrm{Si}}+3\dot{\bar{\mathrm{H}}}$. Garrett found no water, his analyses give the same formula as Erni's, minus the water.

Our results differ essentially from those heretofore obtained, as is seen by the following analyses:

	1.	2.	3.	4.
Silica,	40·29	39·64	40·21	40·96
Alumina,	43·00	42·40	41·50	41·40
Peroxyd of iron,	1·30	1·60	1·50	1·30
Lime,	1·01	1·00	1·88	1·11
Magnesia,	·62	·70	·78	·70
Soda,	3·94	3·94	3·25	3·25
Potash,	5·16	5·16	4·26	4·26
Water,	5·00	5·08	5·91	6·23
	100·32	99·52	99·29	99·21

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* J. f. pr. Chem., liii, 1.

† By the difference.

‡ This Journal, [2], viii, 382; Dana's Mineralogy, 3d ed., p. 362.

No. 1 was from a specimen in our own collection. No. 2 was from the original specimen in Prof. Silliman's cabinet. Nos. 3 and 4 were specimens received from Messrs. Williams and Jeffries of Westchester, Pa. Sp. Gr. No. 1 and 2, 2·83. The analyses give the formula, $\dot{\text{R}}\,\dddot{\text{Si}}+\ddot{\text{R}}_3\,\dddot{\text{Si}}_2+2\dot{\text{H}}$.

	Atoms.	At. weight.	Per ct.	Oxygen ratio.
Silica,	3	1731·93	39·63	9
Alumina,	3	1925·40	44·05	9
Soda,	½	193·60	4·43	1
Potash,	½	394·42	6·74	
Water,	2	225·00	5·15	2

This mineral in its most beautiful form, is of rare occurrence (analyses 1 and 2 are of this variety); there is, however, another variety, not differing essentially in physical characters, or in chemical composition, which is found in considerable abundance at the locality.

In all probability the mineral alluded to as Muscovite? in the memoir on the minerals associated with emery* is this mineral; and when we may be able to get at certain specimens from Asia Minor, containing this mica in a pure state, this point will be investigated. It is of much interest towards tracing out its geological connection with corundum formations widely separated, in which respect it may resemble *emerylite.*

3. *Mica from Litchfield, Conn.*

This mineral is associated with the Kyanite of Litchfield. In general appearance it resembles margarodite. Hardness = 3·35, Sp. Gr. 2·76. Almost colorless, having a faint tinge of green. Transparent. Lustre pearly. The results of two analyses gave:

	$\dddot{\text{Si}}$	$\dddot{\text{Al}}$	$\dddot{\text{Fe}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Mn}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$	Fl	$\dot{\text{H}}$
1.	44·60	36·23	1·34	0·37	0·50	*trace*	4·10	6·20	*trace*	5·26
2.	44·50	37·10		*undet.*	*undet.*	——	4·00	5·90	——	5·16

These correspond very closely with Liebnerite, as well as with Damourite, and some analyses of margarodite. Annexed are the analyses for comparison:

	$\dddot{\text{Si}}$	$\dddot{\text{Al}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\dot{\text{Mg}}$	$\dot{\text{K}}$	$\dot{\text{Na}}$	$\dot{\text{H}}$	
Liebnerite,	44·66	36·51	1·75	——	1·40	9·90	0·92	4·49	Marignac.
			$\dddot{\text{Fe}}$						
Damourite,	45·22	37·87	*trace*	——	——	11·20	——	5·25	Delesse.
Margarodite,	46·23	33·08	3·48	*trace*	2·10	8 87	1·45	4·12	Delesse.

The silica and peroxyds† in these analyses are identical, but in common with many of the micas, it is extremely difficult to deduce any one formula that would be a correct expression of

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* This Journal, [2], xi, 62.

† Considering the iron in Liebnerite as peroxyd.

their chemical constitution, owing to slight differences in the protoxyds. This is rendered more obvious by comparing their oxygen ratios.

	$\dot{\mathrm{R}}$	$\bar{\bar{\mathrm{R}}}$	$\bar{\mathrm{Si}}$
1. Litchfield mica, ...	1 :	7·22 :	9·70
2. Liebnerite, ...	1 :	6·33 :	9·43
3. Damourite, ...	1 :	9·35 :	12·00
4. Margarodite, ...	1 :	6·16 :	8·95

The striking similarity of these species would lead us to suspect, that if new analyses were made of specimens from the original localities, they might prove identical. In all physical characters, except structure, there is a complete correspondence.

4. *Unionite, identical with Oligoclase.*

This mineral was described by Prof. Silliman, Jr., in this Journal, [2], viii, 384. The following are its characters. In general appearance it resembles a soda spodumene. It has a very distinct cleavage in one direction. Lustre vitreous. Color white. Hardness 6. Sp. Gr. 2·61. It is found with euphyllite at the corundum locality near Unionville, Pa. The results of three analyses are as follows:

	$\bar{\mathrm{Si}}$	$\bar{\bar{\mathrm{Al}}}$	$\bar{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	ign.
1.	64·09	21·45	*trace*	0·86	0·69	10·94	1·36	1·02=100·41
2.	64·45	20·97	*trace*	0·77	0·46	10·94	1·36	1·14=100·09
3.		21·70	*trace*	0·85	0·49	——	——	1·02

The third analysis, owing to an accident, is incomplete; the constituents determined are given for comparison. The oxygen ratio of these analyses is very nearly 1 : 3 : 9, which gives the formula $\dot{\mathrm{R}}\,\bar{\mathrm{Si}}+\bar{\bar{\mathrm{Al}}}\,\bar{\mathrm{Si}}^2$. This is the formula of oligoclase: the analyses correspond with that species, and the physical characters being the same, there can be no doubt as to the identity of Unionite and oligoclase.

It is believed that this is the first time that oligoclase has been observed in the United States.

5. *Kerolite of Unionville, Pa., a hydrated silicate of Alumina.*

Associated with euphyllite and Unionite, there occurs a peculiar amorphous mineral, which has been circulated among some American mineralogists under the name of Kerolite. In our examinations of the minerals from this locality, we thought it of sufficient importance to ascertain its chemical composition.

In physical characters it resembles Kerolite. Hardness 2·25. Sp. Gr. 2·22. Color yellowish white. Brittle. Crumbles to pieces when thrown in water. Analysis gave:

$\bar{\mathrm{Si}}$	$\bar{\bar{\mathrm{Al}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Na}}$ & $\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
44·50	25·00	7·75	*trace*	*trace*	22·39=99·64

Of the water 1·04 per cent. were lost by 24 hours' desiccation over sulphuric acid, 8·81 per cent. by heating to 212°, and the remainder at a red heat.

In chemical composition it is near *halloysite.* It is an imperfectly formed mineral, and consequently is not homogeneous; it passes into euphyllite and felspar.

6. *Bowenite, identical with Serpentine.*

This mineral occurs at Smithfield, R. I., and was described by Bowen* as a variety of nephrite. His analysis gave:

$\bar{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Fe}}$	$\overline{\text{Al}}$	$\dot{\text{Mn}}$	$\dot{\text{H}}$
44·69	34·63	4·25	1·75	0·56	*trace*	13·42

This composition differed so much from nephrite, and corresponded so closely to the formula $2(\dot{\text{Mg}}\,\dot{\text{Ca}})^2\,\bar{\text{Si}}+3\dot{\text{H}}$, that Prof. Dana felt himself justified in noticing it as a distinct species.†

The following are the physical characters of the mineral. Hardness 5, (it will scratch glass if rubbed with a little force against its surface; it first gives way, but ultimately scratches the glass.) Sp. Gr. 2·57. Color, in large masses, bright apple green. Highly translucent. Structure granular, and exceedingly tough. We give analyses of three specimens. No. 1 was from the cabinet of Prof. Silliman, Jr., No. 2 from the mineralogical collection of Harvard University, received from Prof. Cook, No. 3 from the Lederer collection in Yale College.

	$\bar{\text{Si}}$	$\overline{\text{Al}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	$\dot{\text{Ca}}$	$\dot{\text{H}}$
1.	42·20	*trace*	42·50	1·56	*trace*	13·28=99·54
2.	42·56	*trace*	43·15	0·95	——	12·84=99·50
3.	42·10	*trace*	41·23	1·11	1·90	12·77=99·11

These analyses give the oxygen ratio 4 : 3 : 2, and the formula $2\dot{\text{Mg}}^3\,\bar{\text{Si}}^2+3\dot{\text{Mg}}\,\dot{\text{H}}^2$, which calculated, is:

$\bar{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$
43·5	43·8	12·7

This is the composition, and formula of serpentine, and the fact of its identity with that species is also borne out by its physical characters.

The large amount of lime obtained by Bowen, was doubtless due to the limestone and tremolite with which it is often very intimately associated; much care is required to separate these substances entirely from the Bowenite, but the mineral so purified, contains no lime.

7. *Williamsite, identical with Serpentine.*

We notice that this species is considered distinct by Prof. Shepard in the last edition of his mineralogy, notwithstanding it has been shown to be serpentine by Hermann;‡ and previously from

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* This Journal, [1], vi, 346.

† Dana's Mineralogy, 3d ed., p. 265.

‡ J. f. pr. Chem., liii, 81.

an analysis made by one of us, published in Dana's Mineralogy, page 692. In this analysis referred to, 3·35 per cent. of alumina and iron were obtained; we have since examined the relative proportions of these substances, and find that the amount was due to iron with but a trace of alumina. Two analyses, made from very pure specimens, gave:

	$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ni}}$	$\dot{\overline{\mathrm{H}}}$
1.	41·60	*trace*	41·11	3·24	0·50	12·70=99·15
2.	42·60	*trace*	41·90	1·62	0·40	12·70=99·22

It is evident from these analyses that the mineral is identical with serpentine, and affords the same formula as the mineral last mentioned. It may be well to remark that great care was taken to see that no magnesia accompanied the oxyd of iron in its precipitation by ammonia; not satisfied with adding an excess of sal-ammoniac to the solution before the addition of the ammonia, we re-dissolved the precipitate. added sal-ammoniac, and re-precipitated the oxyd of iron: this was done even a third time, before the last traces of magnesia were got rid of, or that we were sure that the amount of iron would not be increased by containing magnesia—a circumstance in which sufficient precaution is not always used. What is here said of oxyd of iron is equally true of alumina.

8. *Lancasterite; a mechanical mixture of Brucite and Hydro-magnesite.*

While on a mineralogical excursion to the localities near Texas, Pa., a few months since, in company with Mr. W. W. Jeffries, we observed at Wood's Mine a peculiar magnesian mineral, somewhat resembling Lancasterite; a chemical examination showed it to be *hydro-magnesite.* The composition of it, as well as its strong resemblance to some specimens of Lancasterite, led to a reëxamination of the latter species.

Lancasterite is described as occurring "foliated like Brucite," but sometimes in crystals "resembling somewhat stilbite or gypsum." As we desired to see whether these forms were identical in chemical composition, a portion of the foliated mineral was carefully selected, and the amount of carbonic acid determined—it was but a trace: the magnesia and water being estimated gave the same amount as is found in Brucite; there was also a trace of manganese and iron.

Some of the small crystals "resembling stilbite or gypsum," were then examined; analysis showed them to have the same composition as the hydro-magnesite of Kobell.

These results go to prove that Lancasterite is not a distinct species, but a mechanical mixture of Brucite and hydro-magnesite. In Dr. Erni's analyses of this mineral, (made in the Yale Laboratory,) we are aware he found great difficulty in obtaining a constant composition, and it was only after a series of analyses that he obtained any concordant results. The specimens he examined were both crystallized and foliated, the folia in some cases overlying the crystalline portion. With this explanation the composition he obtained is easily understood.

The following are the results of our analyses. Nos. 1 and 2 were foliated. Nos. 3 and 4 were of the radiated variety.

	1.	2.	3.	4.
Magnesia,	66·30	66·25	42·30	44·00
Protoxyd of iron,	·50	1·00	*trace*	*trace*
" manganese,	*trace*		*trace*	*trace*
Carbonic acid,	1·27	*trace*	36·74	36·60
Water,	31·93	32·75	20·96	19·40
Direct determination of water,			20·10	

The foliated variety gives the exact composition of Brucite. In two determinations of loss by heat, the numbers 34·30 and 35·67 were obtained; great difficulty was found in obtaining the Brucite perfectly pure owing to its intimate association with the hydro-magnesite.

The radiated variety (as before stated) gives the composition of hydro-magnesite, and to show that the original analyses were made from a mixture of these minerals, we give Dr. Erni's results* for comparison.

$\dot{Mg}$	$\dot{Fe}$	$\ddot{C}$	$\dot{H}$	Total.
50·01	1·01	27·07	21·60	99·69
50·72	·96	26·85	21·47	100·00

9. *Hydro-magnesite found crystallized.*

The hydro-magnesite above mentioned is extremely beautiful, and in appearance resembles very much the Thomsonite from Kilpatrick in Scotland. Its structure is highly crystalline and in some instances forms distinct crystals, which have been considered as monoclinic? (Dana); the diagonal cleavage is very distinct. Hardness 3–3·5 (scratching calcite with ease). Sp. Gr. 2·145–2·18. It occurs at Wood's Mine, Texas, Lancaster County, Pa., in seams which are sometimes half an inch in thickness, and at Low's Mine in veins, generally from one-tenth to one-fifth of an inch wide, having a beautifully radiated structure. The results of two analyses of a specimen from Wood's Mine are as follows.

	1.	2.
Magnesia,	43·20	42·51
Carbonic acid,	36·69	35·70
Water,	20·11	21·79
Iron and manganese,	*trace*	*trace*

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* From Dana's Mineralogy, p. 213.

A direct determination of the water gave 19·83 per ct. These analyses give the oxygen ratio 2 : 3 : 2, and the formula

$$3(\dot{Mg}\,\ddot{C}+\dot{\bar{H}})+\dot{Mg}\,\dot{\bar{H}}$$

which calculated gives

$\dot{Mg}$	$\ddot{C}$	$\dot{\bar{H}}$
44·68	35·86	19·46

The composition and formula are the same as obtained by Kobell and Wachtmeister for hydro-magnesite from Negroponte and Hoboken.

We are not aware that this species has heretofore been observed with a crystalline structure.

10. *The supposed Magnesite of Hoboken, shown to be Arragonite.*

In connection with the foregoing investigations, it was thought that an examination of some of the anhydrous carbonates of magnesia might be interesting. For this purpose a specimen of magnesite from Hoboken, N. J., was submitted to analysis, (the variety referred to is that which occupies seams and cavities in the Hoboken serpentine, having an aggregated, fibrous structure and not unfrequently occurring in delicate needle crystals.) A careful qualitative examination of the needle crystals, showed them to be carbonate of lime, with scarcely a trace of magnesia; they have the form of Arragonite. Specimens from Staten-Island and the vicinity of Westchester, Pa., were examined, with like results. The crystals from the serpentine quarry near Westchester are frequently transparent and are among the most beautiful specimens of crystallized Arragonite that have been observed in this country.

Lab. University of Va., Jan. 18th, 1853.

Art. XXV.—*A Consideration of some of the Phenomena and Laws of Sound, and their application in the Construction of Buildings designed especially for Musical Effect;** by J. B. Upham, M.D., Boston.

"Architecture," says Thomas Hope in his well known Historical Essay, "is essentially an art of direct utility."

It more than all others adapts itself to the tastes and habits and occupations of the people. Everywhere this fitness for a definite object, and adaptation of means to the end is apparent. It is an art, too, that keeps pace with the progress of the world, and deigns to accept whatever aids Science and Philosophy may offer for its improvement.

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* The topics discussed in this paper formed the subject of a series of articles recently published in "Dwight's Journal of Music," under the title of "Acoustic Architecture." They are here given somewhat more at length, with such additional thoughts as a further investigation of the matter has furnished.

The connection which Music has with Architecture is analogous to that between the mind and the body. As the former requires for its due exercise the perfection of the latter, so music, when confined within the walls of a building, is dependent, for its full power and expression, upon a certain fitness and adaptation of form and construction. This fitness results, in part, from the associations naturally connected with some styles of architecture. Thus the forms of the ancient cathedrals are most befitting the majestic movements of the oratorio and the solemn mass. We there experience the most sublime effects of music, although this is a result to which the primary design of the architecture did not look. But we also find the deductions from modern science to correspond, in great measure, with these accidental relations; for the forms and proportions of the cathedral partake of those that we should now suggest for structures designed for musical effect. With as good reason, therefore, as the terms naval, military, and ecclesiastical, are applied to architecture, may we not claim for music also a distinctive department in this science?

The subject, in this view, has not yet received from the Profession the attention its interest and importance demand. Throughout the Continent of Europe, and especially in those portions of it we have been accustomed to regard as the home of the arts, this assertion will be found to hold true. While religion, as it should, has received most homage, and the receptacles for paintings and statuary (in latter years more particularly) are arranged with strict regard to their full and proper effect, music has rarely found a fitting abode. If we turn to our own country, this truth is still more apparent. Here, until quite recently, no building of this nature has been erected which has any claim to the observance of correct principles in its construction. England has, it is true, furnished some noble exceptions in this particular. The Birmingham Town Hall, and the Philharmonic Hall at Liverpool are still, without doubt, the finest structures of the kind in existence, and come very near the realization of perfect success.*

It is not our design in the present discussion to encroach at all upon the province of the professional architect, nor to attempt to put forth a theory which shall stand, unscathed in every point, the ordeal of a practical test. We are aware the subject is one beset with peculiar difficulties. Our knowledge of sound and of the laws of acoustics must still be considered very imperfect.

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* Within the past season the Boston Music Hall has been completed and dedicated to its appropriate use. This building embodies in its construction the results of a series of laborious investigations, and experiments made by a committee appointed for the purpose. Considering the uncertain deductions, hitherto of all scientific enquiry on this point, its success may justly be regarded as satisfactory and complete. It is a structure that confers honor alike upon its accomplished architect, and upon the city.

Many collateral circumstances, too, come in to complicate and disturb the best contrived theories of acoustic effect.

Within a few years past, several committees have been appointed by the English Parliament to consider, practically and scientifically, the whole matter, who have summoned before them the most eminent architects of the day, and after profiting by the learning and experience of all, have found their conclusions sadly at variance with each other. They found, too, that facts did not confirm the most plausible doctrines, and were almost led to question the truth of the fixed and immutable laws of science. Where the best authorities thus differ, and science and learning have failed to arrive at satisfactory results, it would be presumption in us to expect to point out a plan that will overcome all previous defects, or to hope to arrive, at once, at perfection. This, if done at all, can only be accomplished after much severe and patient investigation, aided by a series of costly experiments. All we can hope to do here, is to consider candidly what has already been said and written on this subject, and by careful comparison of facts, and the use of whatever further aids philosophy and research may have afforded us, endeavor to reconcile contradictory opinions, and, possibly, suggest a few additional inferences which may prove of practical utility.

We shall commence with a consideration of some of the facts and phenomena connected with the modern approved doctrine of sound, which have a practical bearing upon our subject.

According to the views of Herschell, sounds of all kinds agree in these particulars:

1. The excitement of a motion in the sounding body.
2. The communication of this motion to the air or other medium which is interposed between the sounding body and our ears.
3. The propagation of such motion from particle to particle of such an intermedium in due succession.
4. Its communication from the particles of the intermedium adjacent, to the ear itself.
5. Its conveyance in the ear by a certain mechanism, to the auditory nerves.
6. The excitement of sensation.

Herschell's idea (as set forth in his celebrated treatise in the *Encyclopedia Metropolitana,*) plainly is, that sound, when once produced, is governed by laws almost wholly analogous to those of light, and on this theory alone can its various phenomena be satisfactorily explained and made of practical value.

The propagation of the original impulse in air and other elastic fluid media has been best illustrated by the motion of waves upon the surface of a placid lake. If we drop a stone into a pool of water, a series of elevations and depressions chase each other rapidly along the surface, extending, with equal velocity in every direction, till they gradually subside and mingle in the general level. The movement thus produced in the water, is apparent only. It is the impulse, communicated from particle to particle in the water of which the wave consists, not the motion of the water itself. Precisely analogous to this is the communication of sound in air, except that, in this latter case, as the impression is produced in, rather than upon, the surface of an elastic medium, it spreads equally every way, and would form, instead of concentric circles, concentric spherical laminæ.

The velocity of sound, as also its intensity, varies according to the nature and condition of the medium through which it is transmitted. In a dry atmosphere, and at the freezing temperature, sound travels at the rate of three hundred and sixty-three yards, or one thousand and ninety feet in a second. For every additional degree of Fahrenheit this velocity is increased about one thousandth part.

In the different gases this result is found to vary considerably, the velocity in hydrogen being nearly three times greater, and in carbonic and sulphuric acid gases much less than in common air. Through liquids the velocity is greatly increased, moving in water, at the temperature of 46° 6′ Fahrenheit, at the rate of four thousand seven hundred and eight feet per second.

The propagation or conduction of sound through solid bodies, presents many interesting points of consideration. Solids are good conductors in proportion to their hardness and elasticity, and uniformity of structure; and the better the conducting power of the material the more perfect will be its *resonance*, by which is here understood the power of aiding or increasing the intensity of the original sound. A series of experiments on the conveyance of sound along the cast iron pipes of Paris, instituted by MM. Biot, Bouvard, Malus and Martin, determined its velocity, in that metal, to be about 11,090 feet in a second, or ten and a half times greater than in air.

According to Chladni, the relative velocities of sound in different solids are as in the following table:

	Velocity, in feet, per second.
Tin,	7,800
Silver,	9,300
Brass,	11,800
Baked clay,	10,000 to 12,000
Copper,	12,500
Glass,	17,500
Iron,*	17,500
Woods of various kinds,	11,000 to 18,000

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* It will be seen there is a great discrepancy between the result in iron as here stated, and that obtained by the experiments of Biot. Herschell observes that the error in this case throws a doubt on all the rest; unless, perhaps, steel be meant. —*Encyc. Metropol., Art. Sound.*

Of the woods, fir appears to be among the best conductors, sound being conveyed through it at the rate of 17,300 feet per second.

The intensity, also, of sound differs in media of different chemical and mechanical natures. It varies in atmospheric air with its density or specific gravity. Hawksbee, in his experiments detailed in the London Philosophical Transactions, with an atmosphere in the usual state, heard a bell at the distance of 30 yards. With a force of two atmospheres at 60 yards. With a force of three atmospheres at 90 yards. But he did not notice a corresponding increase of sound with greater densities.

Priestly ascertained by experiment that the sound of a bell in hydrogen gas was scarcely louder than in a vacuum, whereas both in oxygen and in carbonic acid gas it was louder than in air. M. Perrolle found that a sound, which ceased to be heard in atmospheric air at the distance of fifty-six feet, ceased to be heard in oxygen at sixty-three feet, in carbonic acid gas at forty-eight feet, and in hydrogen at eleven feet. Chladni also found that the sound from hydrogen gas in an organ pipe was feeble and difficult to distinguish, while that of oxygen was stronger than that of common air. If hydrogen gas be breathed for a few moments, the effect upon the voice is precisely the same as that noticed by travellers in ascending very high mountains; the vocal tones, in both instances, becoming enfeebled and raised in pitch.

In certain states of the atmosphere sounds are conveyed over water or a surface of frozen snow or ice with remarkable distinctness, and to an almost incredible distance. Instances are well authenticated, in which, under these circumstances, and in the clear still air of a winter's morning, a conversation has been carried on at distances greater than a mile. In the morning, before sunrise, the voice, and occasionally the laugh of the sailors on board of an English man-of-war at anchor off Spithead, have been heard at a place at Portsmouth, distant two and a half miles in a direct line. On the authority of Derham,* the human voice has been heard across the straits of Gibraltar, more than ten miles. The sound of a military band, at the hour of roll-call, has been heard at a distance of twenty-one miles from Edinburg castle.

The effect of sound propagated through mixed media is exceedingly curious and instructive, and, in connection here, deserves our careful consideration. We have already seen the facility with which an impulse is transmitted through a solid substance which is homogeneous and uniform in structure. But if the material or substance has different densities, or consists of different bodies imperfectly mixed, or is interrupted by empty

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* Philosophical Transactions, 1708.

spaces, the sound will either be greatly diminished or entirely destroyed. As an analogous illustration of this, witness the difficulty with which light is transmitted through a glass filled with cracks, imperfections and impurities.

So, also, when the medium is a mixture of gases, vapors or liquids, or a combination of the one with the other, the effect, on both the velocity and intensity of the sound, is still more striking. Mr. Leslie found by experiment that, when the air of a receiver was only half exhausted and the deficiency supplied with hydrogen gas, the sound of an enclosed bell was thereby diminished so as to become scarcely audible. Recognizing, again, the analogy of light and sound, in this respect, Herschell thus illustrates its imperfect transmission through a mixture of different densities.

> "When we add syrup to water, or brandy to water, and look through the glass at a candle before they have combined, the candle will appear like a cloud, or as if we had viewed it through a piece of ground glass. When the light passes from a portion of the water to the brandy, or from the brandy to the water, a part of it suffers reflection, and as the separating surface can seldom be perpendicular to the ray, a part of the light will also suffer refraction. Now, as this must take place many hundred times while the light is passing through a large glass of these imperfectly blended liquids, it is not difficult to understand how we are unable to see objects distinctly through the mixture. With sound the effect is precisely the same, but if the two media are of very different characters, the one a gas and the other a fluid, as in the case of falling rain, or the one a gas and the other a solid, as in the case of falling or newly fallen snow, the scattering and deadening of the sound is still more complete."

The effects here produced are attributed, as in solids, to a want of homogeneity in the medium or substance through which the sound is passed. The explanation given by Mr. Herschell is as follows:

> "The sonorous pulses, in their passage through the mixture, are, at every instant, changing their medium. Now at every change of medium two things happen; *first*, a portion of the wave is reflected and the intensity of the transmitted part is thereby diminished; *secondly*, the direction of propagation of the transmitted part is changed, and the sonorous rays, like those of light, are turned aside from their direct course. Thus the general wave is broken up into a multitude of non-coincident waves, emanating from different origins, and crossing and interfering with each other in all directions. Now, whenever this takes place, a mutual destruction of the waves, to a greater or less extent, arises, and the sound is stifled or obstructed. But of all causes which obstruct the propagation of sound, one of the most effective is, the want of perfect adhesion at the juncture of the parts, of which such medium consists. The effect of this may be conceived, by regarding the superficial strata of molecules of each medium when in contact, as

forming, together, a thin film of less elasticity than either, at which, therefore, a proportionally greater reflection of the wave will take place than if the cohesion were perfect; just as light is much more obstructed by a tissue of cracks pervading a piece of glass than it would be by any irregularity in the composition of the glass itself. Further yet; as the parts of a non-homogeneous medium differ in elasticity, the velocities with which they are traversed by the sonorous pulses also differ, and thus, among the waves which do ultimately arrive at the same destination, in the same direction, some will arrive sooner, some later."

This will account for the phenomena of double sounds, sometimes heard in particular states of the atmosphere, and (it seems to us,) also, for the peculiar harshness and discordant nature of musical tones, when heard in similar circumstances. Every military band which attempts to play in the early morning, when the air is loaded with vapors, and the earth reeking with fogs and exhalations, is conscious of the unusual difficulty attending the effort, and the listener, under such conditions, cannot fail to remark the unsatisfactory nature of the music. Hence we can understand the importance of measures to preserve the air within a concert room in a uniform state.

On the other hand, it is a curious fact, that, in their passage through a bland and pure atmosphere, even inharmonious sounds will amalgamate and strike upon the ear with a pleasant accent. Space or distance, in this case, seems to act as a purifier of sound, sifting out and absorbing the discordant portions, and allowing only those without alloy to pass through. Mr. William Gardiner, author of "Music of Nature," appears to have first called attention to this peculiar fact. Its explanation may be found, in part, perhaps, in the greater permeating power of musical or harmonious sounds over mere noise (for such all discord may be termed) of the same intensity; but it must still be regarded, in great part, as one of the unexplained mysteries of nature. We shall have occasion, also, to refer to this principle, when we speak of the capacity of an apartment requisite to give to music its best effect.

A familiar illustration of the imperfections and alterations which occur in the communication of vibrations from one medium to another in immediate contact, when the homogeneity of either is disturbed, is obtained in the experiment originally made by Chladni:

"If we pour sparkling champaigne into a tall glass till it is half full, the glass cannot be made to ring by a stroke upon its edge, but emits a dull, disagreeable sound. This effect continues as long as the effervescence lasts, and while the wine is filled with air bubbles. But as the effervescence subsides, the sound becomes clearer and clearer, till at last, the glass rings as usual, when the air bubbles have disappeared. By reproducing the effervescence, the sound is again deadened as before. The cause of the result obtained by M. Chladni, is, says Mr.

Herschell, that the glass and the contained liquid, in order to give a musical tone, must vibrate regularly in unison as a system, and if any considerable part of a system is unsusceptible of regular vibration, the whole must be so."

In the case just mentioned, the sound is excited in a solid and transmitted to a fluid medium. The converse of this must also be true, i. e. when a sound passes from a fluid to a solid in contact with it, if this latter medium be not uniform and homogeneous in its structure. Thus every musical performance is modified essentially in its quality by the nature of the structure in which it is given; and hence the importance of attention, in this particular, to the choice of materials, and manner of constructing the walls of an apartment built for musical effect.

On some of the principles just stated can, also, be explained many facts and phenomena in the natural world.

The deep and awful silence which reigns in the elevated regions of the globe is owing, not only to the lack of the ordinary sounds of animated nature, but to the diminished density of the air acting, as we have seen, both to enfeeble and modify the powers of speech, and deaden the force of such sounds as actually exist.

The period of night seems peculiarly adapted to the formation and transmission of sound, especially musical sounds. If we may credit the reports of travellers, the tones of those birds in the equatorial regions which sing at night are singularly plaintive and melodious, as we know to be the case with the mocking bird, the whippoor-will and the nightingale. To certain sensitive minds, almost all sounds, at this season, partake of a musical character; to such there is melody in the running waters of a brook; the hum of insects is a song;—the voice of falling water mingles with the rising wind and the distant surging of the ocean to form a mighty chorus. The hush of nature, even, in the silent eloquence of night, is woven into harmony, and

> "The mute still air
> Is music slumbering on her instrument."

But the attention of the most unimaginative cannot fail, at such times, to be arrested by the prevalence of sounds of which they took no cognizance during the day. In the pure atmosphere that often prevails at night in tropical climates, such phenomena are particularly striking. Humboldt was of opinion that the noise of the great cataract of the Orinoco, when heard at night, in the plains which surround the mission of Apures, was three times louder than during the day. The explanation given by this eminent traveller, and repeated by Mr. Herschell, is as follows:

"In a hot day, when a warm current of air ascends from the heated ground and mingles with the cold air above of a different density, the transparency of the atmosphere is so much affected that every object seen through it appears to be in motion, just as when we look at any distant object over a fire or flame of a candle. The air is, therefore, during the day, a mixed medium, in which the sounds are reflected and scattered in passing through streams and strata of different densities, as in the experiment of mixing atmospheric air and hydrogen. At midnight, on the contrary, when the air is transparent and of a uniform density, as may be seen by the brilliancy and number of the stars, the slightest sound reaches the ear without interruption."

In this greater distinctness of sounds by night, doubtless, something must be attributed to the absence of the usual noises of the day, and the consequent greater sensibility of the auditory apparatus to impressions; but the reasoning above given is philosophically correct.

It is a well known law, and one on which rests the entire fabric of music, as a pleasing Art, that sounds of whatever intensity move with the same velocity. Whether the original impulse be derived from the discharge of a cannon or the most delicate tones of the human voice—whatever be the quantity, pitch or quality of the original impulse, the sonorous wave reaches the ear in equal intervals of time. It would need but the slightest infringement of this law to change our highest enjoyment into the intensest suffering.

A general idea of the divergence and decay of sound is obtained from the illustration before given of dropping a pebble into an unruffled pool; if not interrupted by the surface of a wall or other obstacle, the wave thus produced spreads from its common centre, diminishing gradually in height till, at length, it sinks into the general level. So sounds in empty space, as ordinarily produced, diverge in all directions from the sonorous centre till their energy is lost in the distance. The intensity of sound decays in receding from its origin as the square of the distance increases.

The sympathy of sound and motion is exceedingly curious. Every fundamental note has its complimentary or harmonic adjunct, which an experienced ear can detect along with the original sound; and here the analogy with the phenomena of accidental or harmonic colors holds good. By a sympathetic communication of vibrations, the harmonic sounds can readily be produced.

"If two cords of the same material and equal tension be taken, the one being only one-third the length of the other, and the shorter string be sounded, the vibrations will be communicated to the other by the intervention of the air, which latter will vibrate in three parts each equal to the shorter string and each performing the same number of vibrations in a given time."

This tendency of one vibrating body to throw another into the same state of vibration, is well illustrated in the motion of two or more clocks fixed to the same support. For a long time it has been known that clocks and watches in such a situation will modify each other's motions, and compel a perfect coincidence of action. So two chords or organ pipes, placed in each other's vicinity, and sounded together, will often be found in unison, though their respective notes differ a little when sounded separately. In this way, in a powerful orchestra, one or more refractory instruments are oftentimes compelled to play in tune. On much the same principle we would explain the requirement of harmonic relations in the proportions of a building constructed for musical purposes.

The subject of Catacoustics, or the doctrine of reflected sound, is, perhaps, the most unsatisfactory in its results of any branch of physical science; and, yet, upon its due appreciation depends, in very great measure, our hope of success in the attempt to make the laws of sound of any practical value in their application to the question under consideration.

This part of acoustics may be subdivided into *reflection proper* (which includes echo) and *reverberation.* Much indistinctness appears to have prevailed in the treatment of this subject by authors, as well as a singular want of discrimination as to the precise cause and effect, in the case of many phenomena which are commonly referred to the principle of reflection of sound, and many ingenious theories have been offered to explain the same result. Keeping in mind, however, the strict analogy heretofore observed in the laws of light and sound, it does not seem to us necessary to depart here from the idea of this intimate connection.

If an obstacle, as a blank wall, be interposed between the source of sound and the ear, the sonorous wave is thereby arrested in its direct course, and the indirect pulses only take effect. Could any contrivance be adopted which would mark the track of sound, the space behind such obstacle interposed would be left in shadow; and if water be the medium through which the sound is passed, the occlusion is still more complete, and would, in this case, be equivalent to a total eclipse, as we are taught by experiments actually made. But if the point of the original sound and the hearer be on the same side of the wall, and the ear in a favorable position, both the direct sound and the reflection from the surface of the wall will be heard, producing a reinforcement and slight prolonging of the original note or its distinct repetition, according as the hearer is nearer to or more remote from the reflecting surface.

These effects have often been confounded with resonance. By *resonance*, however, is intended something entirely distinct from reflection, depending, as we have previously seen, on a wholly different principle. By the former a musical tone is sustained and intensified, and, in this way, often improved, but reflection can never otherwise than mar the genuine musical effect, unless, indeed, the hearer is in such close proximity to the reflecting surface that the original note and its reflection are received as one and the same sound. Of course, we must not be understood as speaking here of a single musical note sustained, but of the succession and combination of tones that go to form a musical idea. Resonance is well exemplified in the sounding-board of a piano-forte or the body of a viol, and is, in effect, *synchronous* with the original impulse, while reflection implies some interval between the primary and secondary or reflected sound. Now, in reality, this latter can never happen without some injury to the perfection of a sequence of musical sounds, though, practically, as above suggested, in a room of small dimensions the ear will scarcely be sensible of any confusion from this cause alone. It is in large apartments, (such as we shall see are essential, on other grounds, to the perfection of musical effect,) that we experience the disturbing influence of reflection, which therefore we must study to counteract and obviate by all the means which science has afforded us.

The laws which govern the reflection of sound are, as stated by Mr. Herschell, essentially the same as in the case of light; the angle of incidence, or the inclination at which the sound falls upon the wall, is equal to the angle of reflection or the inclination at which it is returned from the wall.

When the nature of the reflection is such as to cause a distinct repetition of the original sound, one or more times, it is called echo. As regards the nature of echo, and the conditions requisite for its formation, there exists still much uncertainty; it would seem to be but a modification of reflection, as just stated, but it also appears to possess some peculiar laws of its own. By some, it is supposed to be caused by unequal reflections of sound, as well as by conduction, and to require a free space beyond the reflecting surface. At the Marquis Simonetta's villa, near Milan, is a famous echo, where the voice is repeated forty times and the report of a pistol fifty-six times. It has been described by Addison and Keysler, according to the latter of whom it is occasioned by a reflection of the sound between the opposite parallel wings of the building, which are fifty-eight paces from each other, and at right angles to the main body of the structure; and yet the Jesuits erected a precisely similar edifice at Prague, but failed to produce an echo there. Doubtless the state of the atmosphere has something to do with the formation of echo, upon the principles stated in a previous paragraph. At the place first mentioned, according to Addison, the repetitions were more distinct and numerous in a fog. Saunders also states that a house in Lambeth Marsh produces echo in winter, but none in summer.

Very many remarkable echos have been found in our own country. The region of the White Mountains, as almost every one knows, abounds in them. As the writer was journeying in the northern parts of Vermont, in the autumn of 1851, a singularly beautiful echo was noticed on the borders of a small lake, known as Island Pond. The voice, pitched on a high key, was answered distinctly thirty-six times, and the discharge of a fowling piece was followed by a prolonged roar which lasted for several seconds. This experiment was made on an evening following a balmy day in October. A dense forest skirted the opposite edge of the lake, from whose level a series of lofty hills rose in the form of an amphitheatre. The atmosphere had been hazy during the day; but the sky at the time was partially overcast, and the air moist and warm; rain followed the next day.

(To be continued.)

Art. XXVI.—*Considerations on the Theory of Chemical Changes, and on Equivalent Volumes;* by T. S. Hunt, of the Geological Commission of Canada.

In the proposed inquiry we commence by distinguishing between the phenomena which belong to the domain of physics, and those which make up the chemical history of matter. We conceive of matter as influenced by two forces, one of which produces condensation, attraction, and unity, and the other expansion, repulsion, and plurality. Weight, as the result of attraction, is a universal property of matter. Besides this, we have its various conditions of consistence, shape and volume, with the relation of the latter to weight, constituting specific gravity, and the relations of heat, light, electricity and magnetism. A description of these qualities and relations constitutes the physical history of matter, and the group of characters which serve to distinguish one species from another, may be designated the *apparent or specific form* of a species, as distinguished from its *essential form.*

The forces above mentioned modify physically the specific characters of matter, but they have besides important relations to those higher processes, which give rise to new species by a complete change in the specific phenomena of bodies. In the capacity of such changes, consists the *chemical activity* of matter.

It is necessary to distinguish between the production of new species differing in physical characters, and that reproduction which belongs to organic existences. The distinction arises from that individuation which marks the results of organic life, and is eminently characteristic of its higher forms. The individuality not only of the organism, but of its several parts, is more evident as we ascend the scale of organic life, while inorganic bodies have a specific existence, but no individuality; division does not destroy them. Solidity or crystallization is a commencement of individuation, and crystals like the tissues of plants and animals, must be destroyed before they can become the subjects of chemical change; "*corpora non agunt nisi sint soluta.*"

That mode of generation which produces individuals like the parent, can present no analogy to the phenomena under consideration; metagenesis or alternate generation, and metamorphosis, are however, to a certain extent prefigured in the chemical changes of bodies. Their metagenesis is effected in two ways, by condensation and union on the one hand, and by expansion and division on the other. In the first case, two or more bodies unite, and merge their specific characters in those of a new species. In the second case, this process is reversed, and a body breaks up into two or more new species. Metamorphosis is in the same manner of two kinds; in metamorphosis by condensation, only one species is concerned, and in that by expansion, the result is homogeneous, and without specific difference.

The chemical history of bodies is a record of these changes; it is in fact their genealogy. The processes of union and division embrace by far the greater number of chemical changes, in which metamorphosis sustains a less important part. By union, we rise to indefinitely higher species; but in division a limit is met with, in the production of species which seem incapable of farther division, and these being regarded as primary or original species, are called *chemical elements.* These two processes continually alternate with each other, and a species produced by the first, may yield by division, species unlike its parents. From this succession results *double decomposition* or *equivalent substitution,* which always involves a union followed by division, although under the ordinary conditions, the process cannot be arrested at the intermediate stage.

The prevalence of certain modes of division in related species, has given rise to the different hypotheses of copulates and radicals, which have been made the ground of systems of classification; but these hypotheses are based on the notion of dualism, which has no other foundation than the observed order of generation, and can have no place in a theory of the science. A body may divide into two or more new species, yet it is evident that these did not preëxist in it, from the fact that a different division may yield other species whose preëxistence is incompatible with the last; nor can the preëxistence of any species but those which we have called primary, be admitted as possible. Apart from these considerations, it is to be remarked that our science has to do only with phenomena, and no hypothesis as to the noumenon or substance of a species under examination, based upon its phenomena, or those of its derived species, can ever be a subject of science, for it transcends the limits of human knowledge.

For these reasons, it is conceived that the notion of preëxisting elements or groups of elements, should find no place in the theory of chemistry. Of the relation which subsists between the higher species, and those derived from them, we can only assert the possibility, and under proper conditions, the certainty of producing the one from the other. Ultimate chemical analyses, and the formulas deduced from them, serve to show what changes are possible in any body, or to what new species it may give rise by its changes.

Chemical union is interpenetration, as Kant has taught, and not juxtaposition, as conceived by the atomistic chemists. When bodies unite, their bulks, like their specific characters, are lost in that of the new species. Gases and vapors unite in the proportion of one volume of each, or in some other simple ratio, and the resulting species in the gaseous state occupies one volume, so that the specific gravity of the new species is the sum of those of its factors. The converse of this is true in division, and the united volumes of the resulting species, are some simple multiple of that of the parent; in metamorphosis a similar ratio is always observed.

Aside from the apparent exceptions about to be noticed, the weights of equal volumes of gases and vapors are their *equivalent weights*, and the doctrine of chemical equivalents is that of the equivalency of volumes. According to the atomic hypothesis, these weights represent the relative weights of the atoms, and as equal volumes contain the same number of atoms, these must have similar volumes, so that we come at last to the equivalency of volumes. As chemical combination is not a putting together of molecules, but an interpenetration of masses, the application of the atomic hypothesis to explain the law of definite proportions, becomes wholly unnecessary. Chemical species are homogeneous; "*tota in minimis existit natura.*" Solution is chemical union, as is indicated by the attendant condensation; mechanical mixtures are not accompanied by any change of volume.

As two volumes of water-vapor yield one volume of oxygen and two of hydrogen, this was assumed to be the equivalent of water, and of hydrogen, while oxygen was represented by one volume, whose weight was 8, that of the volume of hydrogen being ·5, so that the weight of the equivalent of water was 9. But two volumes of hydrogen unite without condensation, with two of chlorine, and the resulting four volumes of hydrochloric gas, are found to be equivalent to four volumes of chlorine, hydrogen, or water-vapor. Hence four volumes are to be taken for the equivalent of water, and it becomes H_2O_2, with an equivalent of 18, corresponding to HCl, and to volatile species generally, whose equivalents are represented by four volumes of vapor; from these, the equivalents of non-volatile species are determined by comparison.

Hydrogen, chlorine and some other primary species offer apparent exceptions to the general law of condensation and equivalency of volumes. When four volumes of chlorine unite with four of olefiant gas, or naphthaline, the product is condensed into four volumes; but if the chlorine unite with the same volume of hydrogen gas, there is no condensation, and eight volumes or two equivalents of hydrochloric gas are produced. This, however, is explained when we find that four volumes of the chloro-hydrocarbon MH, Cl_2, may break up into four of a new species MCl, and four of HCl, a change which with the chlorid of etherene is effected by the aid of hydrate of potash, and with the chlorid of naphthaline, takes place spontaneously at an elevated temperature. In the production of hydrochloric gas from chlorine and hydrogen, union takes place followed by immediate expansion without specific difference, or metamorphosis, while in its production with the hydrocarbons, we observe the intermediate stage.

If an equivalent of four volumes of hydrochloric gas were to undergo a change like the chlorid of naphthaline, and yield four volumes of chlorine and four of hydrogen, these species would appear with one-half their observed densities; hence we conclude that they are actually condensed to one-half their theoretical volumes, so that four volumes of hydrogen gas represent not H, but H_2. In the same way, if we conceive the quantity of oxygen produced from four volumes of water-vapor, to represent two equivalents, it should equal eight volumes instead of two, so that is condensed to one-fourth, precisely as the vapor of sulphur is condensed to one-twelfth of its theoretical volume. As there are no bodies which are known to yield for four volumes, a less quantity than two volumes of oxygen, this may be taken to represent its equivalent, and the condensation of the theoretical volume, is like that of hydrogen and chlorine, one-half. Water with an equivalent of four volumes is then H_2O, and its weight $2+16=18$; the same formula is deduced by those chemists who take two volumes for the equivalent, and dividing the weight of hydrogen, write water H_2O, with an equivalent weight of 9. The condensation of these elements is that mode of metamorphosis which constitutes polymerism, and evidently offers no exception to the law of equivalent volumes.

The law of Laurent "that the number of atoms of hydrogen, or of hydrogen, chlorine, nitrogen, metals, etc., in any formula corresponding to four volumes of vapor, is always a sum divisible by two," clearly follows from the principles already laid down, and from the fact that nitrogen, and the metals, are subject to the same conditions as hydrogen and chlorine; the *atoms* have the value which has been assigned to H, and to Cl in the formulas given above. The same rule of divisibility, as Laurent has already shown, necessarily holds in regard to the number of atoms of carbon, as well as to the oxygen and sulphur, if we take for their equivalent weights, the numbers 6, 8 and 16 respectively.[*]

It is to be remarked that while the co-efficients of H, Cl or N, in formulas where these are associated, may be odd numbers, those of O, S, and C are always even; this seems a conclusive reason for doubling the equivalents of the latter, or dividing those of hydrogen, chlorine, the metals, etc., according as four or two volumes are taken for the equivalent.

I have elsewhere pointed out that carbon and oxygen sustain such relations, that C_2H_2 may be compared with O_2H_2 and with O_2M_2, and by the substitution of nitrogen for hydrogen, with C_2HN, prussic acid, and O_2N_2 nitrous oxyd, (the so-called compounds of nitrous oxyd with bases are probably O_2MN, corresponding to the cyanids, C_2MN;) while the peroxyd of hydrogen, O_4H_2, corresponds to O_4N_2, nitric oxyd, and to C_4N_2, cyanogen. This relation has important bearings on the history of the cyanic series, and the nitric derivatives of the hydrocarbons.[†]

The formulas of such related species as Gerhardt has designated chemical homologues, differ from each other by nC_2H_2; if now the relation between C and O be what we have supposed, it may be expected that mineral species will exhibit the same relations as those of the carbon series, and the principle of homology be greatly extended in its application. Such is really the case, and the history of mineral species affords many instances of isomorphous silicates, whose formulas differ by nO_2M_2, as the tourmalines, and the silicates of alumina and magnesia, while the latter, with many zeolites, exhibit a similar difference of nO_2H_2. The relation is in fact that which exists between neutral and surbasic or hydrated salts.

Laurent has asserted that salts of the same base, with homologous acids of the type $(C_2H_2)nO_4$, may be isomorphous when they differ by O_2H_2, and has pointed out besides, several instances of what he has called hemi-morphism in species thus related, as well as in others differing by nCl_2. The observations of Pasteur and Nicklès have greatly extended the application of these cases, which assume a new importance in connection with the views here brought forward, and demand further study.[‡]

But to return: we have seen that in gases and vapors, the specific gravity of a species enables us to fix its equivalent, which

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[*] See Laurent's Récherches sur les combinaisons azotées, Ann. de Chimie et de Physique, Nov., 1846, and the American Journal of Science for Sept., 1848, p. 174.

[†] See page 502 of my Introduction to Organic Chemistry, appended to Silliman's "First Principles of Chemistry," Phila.: 1852; and this Journal for January, 1853, p. 151.

[‡] See Laurent, Comptes Rendus de l'Acad., t. xxvi, p. 353, and p. 257 of L. and Gerhardt's Comptes Rendus des Travaux de Chimie for 1848; also Pasteur, ibid., p. 165; and Nicklès, Comptes Rendus des Travaux, for 1849, p. 347.

is often a multiple by some whole number, of that calculated from the results of ultimate analysis. As the equivalents of non-volatile species are generally assumed to be those quantities which sustain the simplest ratio to certain volatile ones, the real equivalent weight corresponding to four volumes of vapor, and consequently the theoretical vapor-density of such species, is liable to a degree of the same uncertainty as those deduced from ultimate analysis. Having, however, determined the true equivalent of a species, from the density of its vapor, the inquiry arises whether a definite and constant relation may not be discovered between its vapor-density, and the specific gravity of a species in the solid state. Such a relation being established, and the value of the condensation in passing from a gaseous to a solid state being known, the equivalents of solids, like those of vapors, might be determined from their specific gravities.

A connection between equivalent weight and density is evident in some allied and isomorphous species. H. Kopp, in dividing the assumed equivalent weights of such bodies by their specific gravities, obtained quantities which were found to be equal for some of these related species. These numbers evidently represent the volumes of equivalents, and in accordance with the atomic hypothesis, are said to denote the *atomic volumes.* The inquiry of Kopp has been pursued by many investigators, among whom are Schrœder, Filhol, Playfair and Joule, and more recently, Dana. Their results show that the volumes thus calculated for related species of similar crystallization, are generally identical, or sustain to each other some simple ratio; while Mr. Dana, who has compared isomorphous species of unlike chemical constitution, finds that the calculated volumes are often to each other, as the number of equivalents of elements, in the formulas representing the species; thus leading to the conclusion that the real equivalent weight is either a mean of that of all the elements, or some multiple of it. The reason of this appears in the fact that the formulas of those species in which this relation is apparent, generally differ in the proportions of Al_2O_3, SiO_3, MgO, CaO etc., and the quantities obtained in dividing the equivalent weights of these by the number of elements, are nearly equal. If we divide by the number of elements, the equivalents calculated from the formulas of those species, it will be seen that the mean equivalents vary with the specific gravity.

These investigations have been principally confined to native and artificial mineral species, and the equivalents have been calculated from the formulas of Berzelius and Rammelsberg, which express the simplest ratios deducible from analysis. While in conformity with the dualistic notions, a mineral like calcite or magnesite was regarded as a compound of one equivalent of carbonic acid and one of lime or magnesia, dolomite was said to be composed of one equivalent of each of these carbonates, or of two to three, as the case might be, while its density was the mean of those of its constituents; thus implying that this union, unlike that observed in gases, is juxtaposition, and not interpenetration. This system of formulas has introduced such difficulties into the study of the relations before us, that we find Mr. Dana led to the conclusion that "the elemental molecules are not combined together or united with one another, in a compound, but that under their mutual influence, each is changed alike, and becomes a mean result of the molecular forces in action."*

The solution of these difficulties is very simple, and will have been inferred from the plan of our inquiry. It is found in the principle that *all species crystallizing in the same shape, have the same equivalent volume;* so that their equivalent weights, as in the case of vapors, are directly as their densities, and the equivalents of mineral species are as much more elevated than those of the carbon series, as their specific gravities are higher. The rhombohedral carbonates must be represented as salts having from twelve to eighteen equivalents of base, replaceable so as to give rise to a great number of species, and the variations in the volume of different carbonates, as observed by Kopp, indicate the existence of several homologous genera, which are isomorphous.

The researches of Playfair and Joule have led them to the conclusion that in some hydrated salts which crystallize with twenty and twenty-four equivalents of water, as the carbonate, the triphosphates and triarseniates of soda, the calculated volume, coincides with that obtained by multiplying the volume of ice (9·8 for HO with an equivalent weight of 9;) by the number of equivalents of water. This result is thus explained; water in these salts is in the same state of condensation as in ice, and 24 HO thus condensed would occupy the volume of $24 \times 9{\cdot}8 = 235{\cdot}$, which is identical with that of the rhombic phosphate, as $20 \times 9{\cdot}8 = 198{\cdot}$ is with that of the carbonate of soda, $C_2Na_2O_6$, 20 HO. Alum, crystallizing with 24 HO, has a volume which is greater than that of phosphate of soda, and according to Playfair and Joule, equals that of the water in the state of ice, with the addition of the bases, the acid being excluded.† In reality, the equivalent volume of alum is to that of the rhombic phosphate as 270 : 235, and 24 HO crystallizing in the monometric system, would have the same volume as alum, with a specific gravity of about ·8, giving for HO, 11·25 instead of 9·8.

What are called the atomic volumes of crystallized species are the comparative volumes of their crystals. In the rhombohedral system, the length of the vertical axis being constant, the volume

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* This Journal, [2], vol. ix, p. 245.

† Chem. Soc. Quar. Journal, i, p. 139, cited in Liebig and Kopp's An. Rep., 1847-48, vol. i, p. 30.

varies with the length of the lateral axes, or in other words, increases as the rhombohedron becomes obtuse, and diminishes as it becomes acute, the cube being the limit between the two. So in the dimetric and trimetric systems, the length of the vertical axis being unity, the volume diminishes as the base of the prism, the specific gravity increasing. Monoclinic and triclinic crystals may be calculated as if derivatives of the trimetric system, with which they will be found to correspond in volume.

It is now necessary to determine what equivalent corresponds to a given specific gravity in any crystalline solid, or in other words, what is the value of the condensation which takes place in the change from the gaseous to the solid state; and here a degree of uncertainty is met with, because the equivalent of a crystallized species may often be a multiple of that deduced from those chemical changes, which only commence with the destruction of its crystalline individuality. The simplest formula deducible for alum is $KO\,SO_3, Al_2O_3\,3SO_3, 24\,HO$, or $S_4K_2\,al_2\,O_{16}, 12H_2O_2$, and hydrogen being unity, its equivalent is at least 474·6, which with a specific gravity of 1·75, gives a volume of about 270. Again grape sugar is not less than $C_{24}H_{24}O_{24}$, if we regard its combination with common salt as corresponding to one equivalent of each, and the ferrocyanids in the same way are represented by C_{12}, etc.; there are reasons for believing that the equivalents of these species in the crystalline state, correspond to some multiple of the above formulas, a question to be decided by an examination of the crystallization and specific gravity of species whose equivalents are admitted to be higher.

Fabve and Silbermann from their researches upon the heat evolved in fusion and solution, have been led to conclude; first, that crystallized salts are polymeric of these same salts in solution, i. e., are represented by formulas which are multiples of those deduced from analysis; secondly, that double salts, and acid salts do not exist in solution, being produced only during crystallization; and thirdly, that water in crystallizing, changes from HO to n HO, n being some whole number.* These conclusions are seen to be in accordance with those deduced from a consideration of the relations of density and equivalent volume; a polymerism is evident in such salts as sulphate of potash and cyanid of potassium, when their specific gravities are compared with those of alum and the ferrocyanid.

In the liquid state, the relation between specific gravity and equivalent is not so apparent in solid species. The condensation often varies greatly, even in allied and homologous species, but still exhibits a relation of volumes. The alcohols $C_2H_4O_2$,

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* Comptes Rendus, xxii, 823–1140, and xxiii, 199–411; cited in Liebig and Kopp's Annual Report for 1847–48, vol. i, p. 40.

$C_4H_6O_2$, $C_{10}H_{12}O_2$, and $C_{16}H_{18}O_2$, have very nearly the same specific gravity, so that the condensation is inversely as their vapor-equivalents. The densities of wine-alcohol, acetic acid and aldehyd in the liquid state, vary as their equivalents, so that the calculated volumes are 57·5, 55·5 and 55. Formic and valeric acids show a similar relation in density to their respective alcohols, their calculated volumes being to these as 37·3 : 39, and 108 : 106·7. If to these we add butyric acid, which gives a volume of 90, and the density of whose alcohol has not yet been determined, the liquid volumes for the four acids $C_2H_2O_4$, $C_4H_4O_4$, $C_8H_8O_4$ and $C_{10}H_{10}O_4$, are 37·3, 55·5, 90, and 108. These numbers approximate to multiples of the liquid volume of water H_2O_2, which is 18; or taking this as unity, are very nearly as 2, 3, 5 and 6. The interval between 3 and 5 corresponds to propionic acid $C_6H_6O_4$, of whose specific gravity I find no recorded observation. The density of many of these liquids is not accurately known, and the results of different experimenters are not precisely accordant. The specific gravity at their boiling points should probably be chosen for the purpose of comparison, and these approximations lead us to expect that future observations will establish a simple relation between the densities of liquids and their vapors.

In a succeeding paper, it is proposed to apply the principles explained in the present essay, in an examination of the equivalents of a number of minerals and other crystallized species.

Montreal, C. E., Dec. 12, 1852.

ART. XXVII.—*New and ready method of determining the Alkalies in Minerals:* Part 1st—*The Quantitative Determination of the Alkalies in the siliceous minerals not soluble in Acids: with a note on a new method of forming the Protoxyd of Nitrogen;* by J. LAWRENCE SMITH, M.D., Professor of Chemistry in the University of Virginia.

1. IN the examination for alkalies in the class of minerals alluded to in this article, it is usual to devote a separate portion of the mineral to their special determination, without having reference to any of the other ingredients contained in the mineral. This method of proceeding naturally recommends itself; because a fusion with carbonate of soda is so greatly superior for the determination of all other ingredients, that even the attempt to control the result of the soda fusion by making use of the one for the alkalies, to arrive at the other substances as well as the alkalies, will in many instances embarrass the analyst as to his results.

2. It is only in cases of absolute necessity that one portion of the mineral should be used to estimate all its constituents, and

this condition of things will be alluded to in another part of this paper, as reference is now had to the quantitative determination of the alkalies, discarding whatever else the mineral may contain.

3. In the determination of the alkalies in silicates not soluble in acids, three important points present themselves:

I. The means necessary to render the silicate soluble.

II. The separation of the other ingredients from the alkalies, more especially magnesia.

III. The removal of the sal-ammoniac unavoidably accumulated in the process of analysis.

In all three of these, the processes adopted will be found to differ essentially from those now in use; and they are made known only after much experience by the author, in which their advantages have been most fairly tested, comparatively with methods already employed. In order that these processes may serve equally well in the hands of others, they will be given with some detail.

I. *Method of rendering the Silicate soluble.*

4. To render the silicate soluble, various plans have been proposed, all of which have their objections. Among the agents used for the purpose, are baryta and several of its compounds, viz.: the nitrate, carbonate, and chlorid.

5. The first of these is undoubtedly the best decomposing agent of the four, could we use a platinum crucible to heat the mixture of it and the mineral; as it is, a silver crucible is necessary, and this is not always capable of standing the requisite heat. According to Rose, "the silver crucible must be very strong, for if thin, the action of a red heat might crack it, and a portion of the fused mass would ooze out through the crevices." It also may happen that a heat higher than the point of fusion of silver is necessary to a complete decomposition of the mineral.

6. All that is here said of caustic baryta is equally applicable to nitrate of baryta.

7. The chlorid of baryum has been lately proposed; but its decomposing properties are very feeble, as the chlorine in combination with the baryum is not liberated at a white heat, and few silicates are able to produce the decomposition. It may succeed with some of the feldspars, but decomposes very imperfectly even the micas. So it is rather a risk to employ it with an unknown substance.

8. The carbonate of baryta is the compound of baryta most generally employed for silica decompositions; still this is attended with much difficulty, owing to the infusibility of this salt, and the impossibility of driving off the carbonic acid by heat alone; and even if this latter were possible, the objection pertaining to caustic baryta would then arise.

9. The following extract from Rose's Analytical Chemistry, (translation by Normandy, in a note by the translator,) presents fairly the difficulties attending this method of decomposing the silicates:

> "The heat applied is so intense, that some precautions must be taken. The platinum crucible containing the mixture should be exposed first to the heat of an argand-lamp, and when the mass begins to agglutinate, the crucible should be closed, and its cover tied down with platinum wire, then placed in a Hessian crucible, closed up also; the whole is placed upon an inverted crucible, and submitted to the action of the blast of a wind furnace, beginning first gradually with a red heat, piling on more coke, so as to fill up the furnace, and increasing the heat to the highest possible pitch, until the Hessian crucible begins to soften. It is absolutely necessary to the success of the operation, that the Hessian crucible should be closed as well as possible, which is best done by luting the cover with fire-clay; the Hessian crucible and its cover having fused together, cannot be separated, except by breaking, &c., &c."

It will be seen in reading this extract, that the heat required is not ordinarily at the command of most chemists, in fact no other variety of furnace than a Sefstroem can be depended on for a complete decomposition.

10. Caustic lime and its salts have also been recommended and long used for the more imperfect decomposition of silicates, as for obtaining lithia from Spodumene and Lepidolite. Lime or its carbonate well mixed with many silicates finely pulverized, will decompose them completely at a white heat, but no one salt of lime is capable of meeting the demand of the entire range of alkaline silicates.

11. In consideration of these difficulties, Berzelius proposed the use of hydro-fluoric acid, and this method when applied with the numerous precautions required, will serve to decompose almost all silicates; still, according to Rose, there are silicious compounds that cannot be completely decomposed by hydro-fluoric acid. Besides, this acid is a most disagreeable one to manipulate with, whether we employ Brunner's apparatus, or Laurent's method, or what is always the best, the *concentrated acid*, previously prepared. I may also add, that the necessity of using sulphuric acid, after the decomposition is made, is another objectionable feature in this process.

12. The above furnishes a hasty review of the methods we are now possessed of for decomposing the silicates, in order to determine their alkalies; their merits can be contrasted with those of the method about to be described.

13. The decomposing agent which I present as a substitute for all others, and as capable of meeting the demands proposed in the commencement of this article, is ***a mixture of carbonate of lime and fluor spar.***

14. Carbonate of lime I have used for more than six years for decomposing certain of the alkaline silicates, and more successfully than carbonate of baryta; still, in numerous instances, the decomposition was far from complete, and the method unsatisfactory. Notwithstanding these failures, I felt convinced that lime was the most powerful decomposing agent that could be conveniently employed for this purpose, as it could be used in its caustic state in a platinum crucible, without injuring the latter, although exposed to the highest temperature: when its carbonate is used, a red heat sufficed to drive off the carbonic acid and bring the mineral under the action of caustic lime, a circumstance that does not take place with carbonate of baryta; and it is well that it does not, for otherwise the platinum crucible would be seriously injured.

15. It was evident, that the only obstacle in the way of lime decomposing the silicates as thoroughly as caustic potash, was the impossibility of fusing the mixture, and thereby bringing the pulverized mineral and lime intimately in contact. This difficulty overcome, I felt confident of success. Without detailing the various methods resorted to, it will suffice to state that the object in view was, to use some flux along with the mixture of the silicate and lime, which would render the mixture fluid at a bright red heat. The two substances which recommend themselves, after many experiments, are the fluorid and chlorid of calcium, neither of which have any marked decomposing action on the silicates; in fact their action is simply that of fluxes, which enable the lime and silicate to come in contact in a liquid state, effecting nothing beyond that. It is with the *fluorid of calcium* that we have to do in this part of the paper, leaving the details on the use of the chlorid of calcium until farther experiments are made to test fairly its value.

16. The manner in which I proceed is as follows:

Pulverize the silicate to a sufficient degree of fineness—it is not required that the levigation be carried to any great extent; mix intimately, in a glazed porcelain mortar, a weighed portion of the mineral with one part of pure fluor spar, and four to five parts of precipitated carbonate of lime,* introduce it into a plati-

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* The fluor spar used, is the transparent variety, free from all impurities; it is easily and abundantly procured in this as well as in all other countries. The carbonate of lime is made by dissolving calc spar or pure marble in hydrochloric acid, (the common acid may be used,) adding an excess of the carbonate; lime water or milk of lime is then poured on the solution until it is alkaline. By this means any oxyd of iron, alumina, or magnesia will be thrown down. To the filtered solution, a solution of carbonate of ammonia is added, and the precipitate washed several times with distilled water. It is best to prepare one's own carbonate of lime, for as a general rule, little reliance can be placed on the carbonates of lime, baryta, strontia, &c., sold as being precipitated by carbonate of ammonia, for in more than one instance, I have found the carbonate of baryta sold as a carbonate of ammonia precipitate, to contain soda.

num crucible capable of holding three times the bulk of mixed powder. The platinum crucible should then be placed in one of earthern ware, with a little magnesia on the bottom. (I always prefer the crucible made in France, called Beaufay's crucible to enclose platinum crucibles, when heated in a furnace, as their form and cleanliness make them superior to the Hessian crucible for this purpose.) The crucible may then be covered and introduced in any form of furnace where a bright red heat can be procured.

17. I have been using a common open portable furnace, heaping charcoal over the top of the crucible; and so easily does the effect take place, that in no instance has there been a failure of complete decomposition with as simple a means of heating as the above, and I have ascertained that an alcoholic lamp, with a large circular wick, such as Jackson's lamp, urged with a bellows, will answer for making a complete decomposition of Zircon in twenty-five minutes. This circumstance is not stated to recommend the use of a lamp for every mineral decomposition, when a simple portable furnace and charcoal are so accessible, and their effects so much more to be depended upon than a lamp. From 30 minutes to one hour's exposure to the heat is recommended.

18. It was an important point to test first how far this mixture could decompose the silicates without distinction as to their containing alkalies; for it was a very simple conclusion, that if those silicates most difficult of decomposition, and containing no alkalies, were completely decomposed by this process, all others must naturally give way under its action. The silicates experimented on, were ***Zircon**, **Kyanite**, **Beryl**, **Topaz**, **Spodumene**, **Margarite**, **Margarodite***, and ***Feldspars of different descriptions***. All were readily decomposed by the method just described, and without any particular care in levigating them; one gramme of the Zircon, for instance, after being crushed in the diamond mortar, was rubbed up for fifteen minutes in a large agate mortar, and used. Its complete decomposition was not only shown by its solution in hydrochloric acid, but by the amount of zirconia obtained—which was 64·8 per cent. with little iron. This concludes the first point to be considered in this article, namely, the means necessary to render the silicates soluble; the next point is the separation of the alkalies.

II. *Separation of the other ingredients from the Alkalies.*

19. The platinum crucible with its fused contents, is laid on its side in a capsule of platinum or porcelain, the latter can be used with perfect safety to the accuracy of the result. A quantity of dilute hydro-chloric acid is poured into the capsule, one part of acid to two of water; the whole is heated over a lamp,

when the contents of the crucible are rapidly dissolved out, the crucible is taken out and washed over the capsule, the contents of the capsule are then evaporated to dryness over a sand-bath, and if thought necessary, it may be completed over the lamp, without danger of the spitting which occurs in the soda fusion; this evaporation to dryness is not absolutely necessary, but the advantage of it is, that any great excess of hydrochloric acid is got rid of, and the precipitate in the next operation is less bulky than it otherwise would be.

20. To the dry mass a little hydrochloric acid is added, and then three or four ounces of water, or more, as the occasion may require; it is then boiled for a short time in the same capsule, allowed to cool down a little, and then a concentrated solution of carbonate of ammonia is slowly added until there is an excess of the same; the solution becomes at first quite thick with the precipitate, but in a short time (especially with a little warming over the lamp) the precipitate accumulates in a more or less granular state, and afterwards occupies less space in the filter than the alumina it might contain (in a feldspar, for instance,) were this latter precipitated separately by ammonia; and this circumstance is of much importance in diminishing the length of the operations and the amount of water accumulated by filtering it from several precipitates.

21. It will be seen that thus far, the operations have been carried on in the capsule in which the fusion was dissolved. The contents of the capsule are now thrown on a filter, but before doing this, it is well to pour on a little of the solution of the carbonate of ammonia, and see if the clear part of the liquid be rendered turbid, in other words, ascertain if sufficient carbonate of ammonia had been originally added.

22. The solution that passes through the filter contains much sal-ammoniac, the alkalies of the mineral, and a little lime. If magnesia be one of the ingredients of the silicate examined, some of this is also present; and in still rarer instances some of the earths soluble in carbonate of ammonia. This last complicates in no degree the remaining steps in the analysis. It is best to let the filtrate pass into a glass flask; the washings of the filter are collected in another vessel, and concentrated to a small bulk, added to the first filtrate, and the whole boiled for some time to drive off the carbonate of ammonia.* When no great haste is required in the matter, the whole filtrate (first portions as well as the washings) are collected in a beaker, and concentrated over a sand-bath. What remains now to do, is to separate from the alkalies the substances above alluded to. I commence by getting

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* What remains in the filter is silica, alumina, fluorid of calcium, oxyd of iron, carbonate of lime, &c.

rid of the sal-ammoniac, and this brings me to the third part of this paper.

III. *The removal of the Sal-ammoniac unavoidably accumulated in the process of Analysis.*

23. This is probably one of the greatest annoyances to the analyst in his examination of minerals; first, from the manner in which the salt creeps up the sides of the vessel in which the evaporation to dryness is carried on, and secondly from the great difficulty of preventing loss of the chlorids of the fixed alkalies, during the volatilization of the sal-ammoniac. A better idea is formed of this by an experiment with a known quantity of the alkalies mixed with sal-ammoniac. An array of the precautions requisite to be taken, can be seen in Rose's last edition (German) pages 6 and 7. Owing to these difficulties, which my experience has often led me to contend with, the method about to be mentioned was contrived; it recommends itself both on account of its simplicity and certainty of operation.

24. Having some time back noticed the decomposing effect produced by heating sal-ammoniac with nitric acid, the nature of the decomposition was investigated to see how far it could be made use of to decompose entirely the sal-ammoniac; the result of the investigation was that the sal-ammoniac could be completely decomposed at a low temperature into gaseous products, and it was immediately adopted in my analytical process with the greatest satisfaction, both as to accuracy of results, as well as economy of labor.*

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* *Formation of almost pure Protoxyd of Nitrogen by the action of Nitric acid on Sal-ammoniac.*—The experiments made with the nitric acid heated with sal-ammoniac, to test the character of the decomposition, have resulted in the discovery of a new method for procuring protoxyd of nitrogen with the aid of a very low temperature. Among the experiments, the following were quantitative. Two grammes of sal-ammoniac were placed in a glass flask, and half an ounce of nitric acid poured upon it, the flask was connected with a small wash bottle containing a little water, and from this latter a tube passed into a pneumatic trough filled with hot water, heat was applied to the flask, and before the temperature reached 140° Fah., a gas began to be given off, and at 160° it came off rapidly, and continued to do so after the lamp was withdrawn. A small amount of red fumes appeared in the flask, that were condensed in the wash bottle, the gas that passed over was collected in a receiver, and measured 1008 cubic centimeters; the gas smelt of chlorine, the flame of a candle burnt with an increased brilliancy when introduced in it, the candle was re-ignited when extinguished, if a burning coal remained on the end of the wick—no red fumes were formed when it came in contact with the air, and the gas was absorbable by cold water. The properties were those of protoxyd of nitrogen. In another experiment the gases were collected at different stages of the process, in phials over hot distilled water, and a solution of caustic potash introduced and shaken up for some time; this latter was subsequently analyzed for the chlorine it absorbed, and in three different portions, collected at the beginning, middle and end of the process, the proportions of the chlorine to the whole bulk of the gas were $\frac{1}{57}$, $\frac{1}{29}$, and $\frac{1}{16}$. The amount of protoxyd of nitrogen due to the ammonia in two grammes of sal-ammoniac and its equivalent of nitric acid, is 887 cubic centimeters. The gas freed from chlorine, on being shaken up with cold water for some time, was

25. The manner of proceeding is as follows. To the filtrate and washings concentrated in the way mentioned (22) and still remaining in the flask, pure nitric acid is added—about three grammes of it to every gramme of sal-ammoniac supposed to exist in the liquid; a little habit will suffice to guide one in adding the nitric acid, as even a large excess has no effect on the accuracy of the analysis.

26. The flask is now warmed very gently, and before it reaches the boiling point of water, a gaseous decomposition will take place with great rapidity. This is caused by the decomposition of the sal-ammoniac in the manner described in the note. It is no advantage to push the decomposition with too great rapidity; a moderately warm place on the sand-bath is best adapted for this purpose. With proper precautions the heat can be continued and the contents of the flask evaporated to dryness in that vessel; but it is more judicious to pour the contents of the flask, after the liquid has been reduced to a half an ounce, into a porcelain capsule (always preferring the Berlin porcelain) of about three and a half to four inches diameter, inverting a clean funnel of smaller diameter over it and evaporating to dryness on the sand-bath or over a lamp. I prefer the latter, as at the end of the operation the heat can be increased to four or five hundred degrees.

27. By this operation, which requires no superintendence, one hundred grammes of sal-ammoniac might be separated as easily and safely as one gramme from five milligrammes of alkalies, and no loss of the latter be experienced. What remains in the capsule occupies a very small bulk; this is now dissolved in the

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found to be almost entirely absorbed by the water. What remained was a mixture of nitrogen and a little air, some nitrous or hyponitrous acid forms during the whole process, if concentrated nitric be used; if, however, it be diluted, little or none is formed, and the gas is readily given off at about 212° Fah.

In all my experiments, the protoxyd of nitrogen constituted from seven-eighths to twenty-four-twenty-fifths of the gaseous products, and when washed from its chlorine by a little lime-water or soda, possessed all the properties of pure protoxyd of nitrogen, and I would recommend it as a convenient way of forming this gas, especially when not required for respiration.

The character of the decomposition which takes place, is somewhat curious and unexpected. At first, I supposed that the decomposition resulted in the formation of equal volumes of NO, Cl, and N, but it appears that such is not the case, and that all but a very small portion of the ammonia with its equivalent of nitric acid is converted into NO; the liberated hydrochloric acid mixing with the excess of nitric acid; a little of the sal-ammoniac and nitric acid, does undergo the decomposition first supposed, and in this way only can the small amounts of chlorine and nitrogen be accounted for. At the time this method was first tried, I also tried the decomposing effects of nitrate of ammonia on sal-ammoniac, that has been shown by Maumené (Comptes Rendus, Oct. 15, 1851,) to result in the formation of chlorine and nitrogen; but the difficulty of controlling the decomposition once commenced, the puffing up of the mixture, and the necessity of having the salts dry to begin with, render this method (which was proposed by the author for forming chlorine) useless in processes for removing the sal-ammoniac in analysis.

capsule with a little water, (the funnel must be washed with a little water,) small quantities of a solution of carbonate of ammonia added, and the solution gently evaporated nearly to dryness. This is done to separate what little lime may have escaped the first action of the carbonate of ammonia or may have passed through the filter (22) in solution in carbonic acid. If any of the earths soluble in carbonate of ammonia existed in the mineral, those now become separated along with the lime.

28. A little more water is now added to the contents of the capsule, and the whole thrown on a small filter; the filtrate as well as washings are received in a small porcelain capsule. The liquid contains only the alkalies (as chlorids and nitrates) mixed with a minute quantity of sal-ammoniac. This is evaporated to dryness over a water-bath, and then heated cautiously over the lamp to drive off what sal-ammoniac may have formed (27) which is exceedingly minute if the process as pointed out be closely adhered to. It is not absolutely necessary to heat the capsule over the lamp, to get rid of the sal-ammoniac, for the little sulphate of ammonia which may be formed in the next step is easily removed in the final heating in a platinum vessel.

29. On the contents of the capsule, as taken either from the water-bath or as after being heated over the lamp, pure dilute sulphuric acid is poured (1 part acid, 2 water) and the contents boiled for a little time when all the nitric acid and chlorine in combination with the alkalies will be expelled; the acid solution of the alkalies is now poured into a platinum capsule or crucible, evaporated to dryness, and ignited. In order to insure complete reduction of the bisulphates into the neutral sulphates, the usual method must be adopted of throwing some pulverized carbonate of ammonia into the platinum capsule or crucible, and covering it up so as to have an ammoniacal atmosphere around the salt, which will ensure the volatilization of the last traces of free sulphuric acid. The alkalies are now in the state of pure sulphates and may be weighed as such. The manner of separating the alkalies from each other will be mentioned in the second part of this paper.

30. Thus far the mineral has been supposed to contain no magnesia. If this alkaline earth be present, we take the residue as found in the capsule, (26) dissolve it in a little water, then add sufficient pure lime-water,* to render the solution alkaline; boil and filter; the magnesia will in this simple way be separated from the alkalies. The solution which has passed through the filter is treated with carbonate of ammonia in the manner alluded

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* If lime water be made it is well to make it of lime of the best quality, and the first two or three portions of distilled water shaken up should be thrown away as containing the small amount of alkalies sometimes present in lime.

to (27) and the process continued and completed as described (28, 29).

In the second part of this paper qualitative examinations of the alkalies in silicates will be alluded to, as well as the separation of the alkalies from each other.

Summary.—Fuse one part of mineral with one of fluorid of calcium and four to five of carbonate of lime; dissolve out the contents of the crucible with hydrochloric acid; evaporate to dryness and redissolve; precipitate with carbonate of ammonia; filter, boil and concentrate the filtrate; add nitric acid, heat and evaporate to dryness; dissolve the dry mass in a little water and treat with carbonate of ammonia; filter and concentrate, then add sulphuric acid, boil for a little while; pour in a platinum crucible, evaporate to dryness and ignite. If magnesia be present treat with lime-water prior to the last application of carbonate of ammonia.

Laboratory of the University of Virginia, Jan. 21st, 1853.

Art. XXVIII.—*Abstract of a Meteorologial Journal kept at Marietta, Ohio, for the Year* 1852: Lat. 39° 25′ N., and Long. 4° 28′ W. of Washington; by S. P. Hildreth, M.D.

MONTHS.	THERMOMETER.							BAROMETER.		
	Mean temperature.	Maximum.	Minimum.	Fair days.	Cloudy days.	Rain and melted snow in inches.	Winds.	Maximum.	Minimum.	Range.
January, ...	24·66	60	−23	13	18	2·08	N. & W. & S. W.	29·80	28·65	1·15
February, ...	35·23	60	12	15	14	3·66	W., S. W. & E.	29·75	28·55	1·20
March, ...	44·53	76	12	12	19	4·30	N., N.W. & E.S.E.	29·90	28·98	·92
April, ...	47·70	78	26	14	16	7·58	N. & W. & S. E.	29·44	28·55	·89
May, ...	61·70	85	36	20	11	4·21	S. & S. W., N.	29·80	29·10	·70
June, ...	67·33	88	42	21	9	5·70	S. & W. & N.	29·70	29·00	·70
July, ...	73·00	92	51	27	4	3·84	S. S. W. & N.	29·64	29·08	·56
August, ...	67·80	85	50	22	9	3·50	S., S. E. & N.	29·65	29·15	·50
September, . . .	64·17	88	37	22	8	1·08	W., S. W. & S. E.	29·65	29·05	·60
October, ...	58·00	86	33	19	12	2·30	S. W. & N.	29·60	29·20	·40
November, . . .	42·00	66	20	8	22	4·50	W., S. W. & S. E.	29·75	28·70	1·05
December, . . .	40·30	62	16	10	21	3·75	S. W., S., W., S. E.	29·70	28·90	·80
Mean for the year, .	52·20					46·50				

Remarks on the Year.—The mean temperature for the year is 52°·20, varying but little from the annual average of this locality. The extreme cold of January had no great influence in reducing the mean heat for the year. On the morning of the 20th of January the mercury in Fahrenheit, fell to 23° below zero at Marietta: at other points higher up the Muskingum river, it sunk to 27°, 28°, and 30° below—at Union, five miles above the mouth, at 2 o'clock in the morning it had fallen to -27°; at sunrise it was at -23°—at Waterford, twenty miles above, the thermometer of my friend, Doct. G. Bowen, at 2 A. M. indicated a fall to -30° below; as daylight appeared it rose to -25° or -24° —at Zanesville it fell to -27°, and remained at that all the latter part of the night, being observed each hour by Mr. Coxe.

The cold seems to have travelled in currents or veins; being more intense in the valley of the Muskingum than in any other portion of the State. The centre of the river valley is from one hundred and fifty to two hundred feet lower than the adjacent country, and the coldest air being the heaviest, would descend into the lowest places. It has been remarked that the cold was greater in valleys than on the adjacent hills; and in localities not half a mile a part, a difference of ten or fifteen degrees has been often noticed when thus situated. At Cleveland, two or three degrees north of Marietta, the mercury fell to only sixteen below. Large bodies of water have an ameliorating effect on climate, but as the lake was nearly covered with floating ice, it could have had little influence in lessening the intensity of the cold. The surface of the earth was covered with snow about ten inches deep, which aided much in giving effect to the frost. At the time of the severe weather in February, 1818, the snow at Marietta was two feet deep; on the 8th of that month the mercury stood at 22° below zero, and on the 9th at 20° below: while in 1852, the cold was intense only on one night, being at zero only on the 19th, and twelve above on the 21st. The longer continuance of cold in 1818, was more destructive to trees and shrubs than at this time, killing sassafras and spice bush, with every peach tree in the country down to the surface of the snow. It now destroyed the peach in low grounds but not on the hills—also quince trees, killing the fruit buds and small branches of the Catawba and Isabella grape, so that my vines produced only a few scattering clusters. The wood of the Pyrus japonicus was generally killed down to the ground or the surface of the snow; especially the variety with flesh colored blossoms, which is less hardy than the scarlet: several other Chinese plants suffered severely from the cold, amongst which was the tree peony Spirea prunifolia brought out by Mr. Fortune a few years since, was nearly destroyed; Weigelia rosea and Forsythia viridisima, stood the trial very well, the latter being partly protected by a piece of matting. The Weigelia bloomed in great perfection, and is one of the most beautiful of all the hardy flowering shrubs that I have seen. Even our native evergreens, Kalmia latifolia, and Rhododendron, suffered severely in their flower buds, not opening a single blossom. Chinese Arborvitæ was killed outright. The Judas tree was dressed in mourning, not showing any of its rich purple flowers; while the Cornus Florida was not at all disturbed, but bloomed with the usual profusion and beauty. Coming as it does at the same time with the Judas tree, the latter was much missed on the hill sides and forrest openings. It will take several years to replace our peach orchards in their former flourishing condition.

The amount of rain and melted snow for the year is forty-six inches and fifty-hundredths; being somewhat over the average amount, which may be placed at forty-two inches, or three and a half feet. The greatest quantity in any one month, fell in April, being seven inches and $\frac{70}{100}$ths. The rain was pretty equally distributed, falling at those times where most needed for the sustenance and growth of plants.

Winter.—The mean temperature of winter was 29°·29, which is several degrees below the usual mean.

Spring.—The mean of the spring temperature was 51°·31, and is rather lower than common, it often being about equal to the mean of the year. Vegetation was rather backward; vernal flowers seemed shy of appearing, and kept behind their usual time. On the 24th of March, there was quite a noted snow storm, falling near four inches, but melting soon after; it had but little influence on the temperature, the mercury standing at 36° and 40° during its continuance. In April the Ohio river was visited with a flood that covered all the bottom lands—on the Monongahela, at Brownsville, the water was higher than at the great flood of 1832—at Pittsburgh nearly as high—at Wheeling thirteen inches lower, and at Marietta four and a half feet below. It was at its height on the 20th and 21st of the month, with us; at Brownsville on the 17th; the water occupying about 72 hours in its descent, or traveling at the rate of one hundred miles in twenty-four hours. The flood is so much wasted, or taken up by the mouths of creeks, inlets, and a broader river-bed, that a rise of six feet at Pittsburgh, makes only two feet at Marietta, with all the aid of intervening affluents. At the period of its greatest height, plum, pear and cherry trees were in bloom, many gardens made, and fields of corn planted. The fruit of currants and gooseberries was destroyed, where covered by the water.

Summer.—The mean temperature of summer was 69°·38, which is rather low, being cool for this climate. July was the hottest month, being 73°. The greatest heat was 92°, while in August it was only 85°. In June it was not above 88°, so that the summer was a very agreeable and pleasant season; ripening the fruits in due time, and completing the growth of crops of grain and grass in great perfection.

Autumn.—The mean of autumn was 54°·72, showing a very mild and temperate season; there being no frost to destroy plants until the 10th of November. The latter half of that month was cold and stormy, with flights of snow.

Floral Calendar.—March 8th, Pewee heard; 10th, Yellow Crocus in bloom; 15th, white and purple Crocus; 17th, Hepatica triloba—a week later than usual; 19th, Cat-bird heard, Crown Imperial one and a half feet high.

April 3d, Crown Imperial in bloom; 11th, Sanguinaria Canadensis, Hyacinth; 17th, Plum and Imperial Gage; 23d, Peach in bloom on the hills, where it escaped the cold of January; 26th, Pear tree; 27th, Apple tree—it is usually a week or more behind the Peach, but this year nearly at the same time.

May 8th, Quince in bloom, where it escaped the cold; 9th, Cornus Florida; 13th, Tradescantha virg.; 14th, Weigelia rosea, Syringa fragrans; 15th, Mocasin flower, yellow and white; 24th, Locust tree; 27th, Syringa Philadelphica.

June 18th, White Lily, and Amaryllis formosissima; 21st, Red Raspberry ripe; 28th, Wheat harvest begins; 29th, Asclepias decurrens in bloom.

July 2d, Actea racemosa in bloom; 4th, Early Chandler apple ripe; 22d, Blackberry ripe.

Art. XXIX.—*On a probably new element with Iridosmine and Platinum, from California;* by Dr. F. A. Genth.*

I received from Dr. Charles M. Wetherill a small quantity of white grains, which were collected in 1849–50 from California gold by the late Jos. R. Reynolds, Esq. An examination of these grains furnished me results which are, perhaps, worth noticing.

I. When treated with boiling hydrochloric acid, two grains began to dissolve with disengagement of hydrogen. As soon as I observed this reaction, I picked them out and washed them off with water. With a good magnifying glass I found that they were mechanically mixed with gold. Their color was between a tin-white and steel color; they were malleable, but harder than tin; they dissolved in nitric acid, yielding a crystalline salt, the native gold which was mixed with them remaining undissolved. They precipitated copper from solutions but slowly. Hydrosulphuric acid precipitated the solution in nitric acid brown. A pure piece of the metal before the blowpipe on charcoal fused readily. It was soon covered with a black oxyd and gave no incrustations. Borax in the O. F. dissolved it and gave a colorless bead, which on cooling became opalescent; the same reaction took place more readily in R. F.

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* From the Proceedings of the Acad. Nat. Sci., Philad., Dec., 1852, p. 209.

The quantity of this metal was too small for further experiments, but these reactions show that it is neither tin nor any other known element, although it has some relations to tin; but it is distinguished from it—

1. By its solubility in nitric acid.
2. By its brown precipitate with hydrosulphuric acid.
3. By not being readily oxydized before the blowpipe into a white oxyd, and by its other blowpipe-reactions.

May not the grains of native tin observed by Hermann in the auriferous sands from Siberia be the same substance?

II. An examination of the white grains, which were insoluble in hydrochloric acid, gave (after a few scales of native gold had been extracted by quite diluted aqua regia) the following results.

Of 0·9366 grms. were 0·4625 grms. or 49·4 p. c. Sisserskite ($Ir\,Os_4$) in brilliant lead-colored scales, some of which were imperfect six-sided prisms.

The remaining grains and scales (0·4741 grms.) had a tin-white color and were treated with aqua regia, as long as it acted upon them. Three rounded grains remained undissolved in aqua regia, which, I suppose, were Platin-Iridium. They weighed 0·0202 grms. = 2·2 p. c.

The balance of 0·4539 grms. or 48·4 p. c. was native Platinum.

The composition of the sample received by Dr. Chas. M. Wetherill was therefore

New element and gold,	not estimated.
Sisserskite, . . .	= 49·4 p. c.
Platin-iridium, . .	= 2·2 p. c.
Native platinum, . .	= 48·4 p. c.

This native platinum is not pure, but contains, like that from other localities, other substances, both alloyed and mechanically mixed with it.

When the 0·4539 grms. were dissolved in aqua regia, 0·0031 grms. or 0·68 p. c. of Sisserskite remained undissolved in minute and fine scales.

The solution was evaporated to dryness in a water-bath, dissolved in alcohol and precipitated with chlorid of ammonium. The brick-red double salt thus formed was washed out with alcohol, then dried and powerfully heated. The ignited residue weighed 0·4206 grms. It was treated with weak aqua regia, which left undissolved 0·0110 grms. of Iridium and Rhodium = 2·42 p. c. (This is of course, only an approximate estimation of Iridium, etc.) This presence of Rhodium and Palladium was also ascertained, but I did not make any quantitative estimations, because the quantity I had to dispose of was entirely too small for the estimation of substances which can be separated only with the greatest difficulty.

The filtrate from the double salts of Platinum, etc., precipitated by ammonia gave 0·0432 grms. of sesquioxyd of iron = 6·66 p. c. of iron. The composition of this native Platinum is therefore

Platinum, (with palladium,) .	= 90·24
Iridium, (with rhodium,) .	= 2·42
Iron, ...	= 6·66
Sisserskite, ...	= 0·68
	100·00

Art. XXX.—*On the Causes which may have produced Changes in the Earth's Superficial Temperature;* by W. Hopkins, Esq., M.A., F.R.S., Pres. G.S., and Pres. Cambridge Phil. Soc. —With a Map.

(Continued from p. 86.)

1. *On the Height of the Snow-line and Descent of Glaciers below it at the present time.*

20. Knowing the mean annual temperature at any place on the earth's surface, we can calculate for that place the height at which the mean annual temperature of the atmosphere will be that of freezing, provided we know the rate at which the mean temperature decreases, in ascending from the lower into higher regions of the atmosphere. This rate has been determined with sufficient accuracy for our purpose. It is necessary to make a distinction between those observations which have been made in balloons or on the sides of comparatively steep mountains, and those which have been made on extensive elevated table-lands; the results in the two cases being very different. Of the first class, Humboldt has given us* the results of nine cases, in which the observations were made at different heights, varying from about 5,000 to 18,000 feet. The mean of the results gives 191·4 metres, or about 638 feet for 1° Cent., which is equivalent to 355 feet for 1° Fahr. In Gay-Lussac's balloon ascent, the observations gave 193 metres for 1° C., up to the height of about 12,000 feet. At greater heights the decrease of temperature was somewhat more rapid, and was at the rate of 1° for 187 metres for the whole height ascended, which amounted to upwards of 23,000 feet. We may adopt, without risk of material error, 190 metres for 1° C., or 350 feet for 1° F. In some particular cases, however, 320 feet would probably be nearer the truth.

Humboldt has also made some valuable observations, which show the effect of extensive high table-lands in raising the temperature above that which would be given by calculations found-

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* Recueils Astronomiques of his Travels in S. America, vol. i, p. 129.

ed on the result just enunciated. In ascending from one table-land to another, the decrease of temperature is much slower than if we should ascend in a balloon, or up the side of a steep mountain. The following table exhibits the results of Humboldt's observations on four of the highest table-lands on the new continent:

Place of observation.	Latitude.	Height.	Mean temperature.	Increase of height for 1° C.
	° ′	metres.	°	metres.
Quito, - - - - - -	0 13 S.	2907	15·0 C.	244·4
Popayan, - - - - -	2 26 N.	1796	20·6	288·1
San. Fé di Bogota, -	4 35 N.	2660	16·5	256·0
Mexico, - - - - - -	19 26 N.	2277	16·9	249·3

The mean of the numbers in the last column is 258·4 metres. This is equivalent to 478 feet of height for 1° F., instead of 350 feet, as in the former case. The high general temperature of the plains of Tibet (as indicated by the nature of their produce), in proportion to their enormous elevation, is doubtless due to the same cause.

From these results it appears, that we may take a decrease of 1° F. as corresponding to an elevation varying, according to circumstances, from 320 to 500 feet; the smaller number being applicable to small, or, if high, very steep mountains, and the latter to large massive ranges presenting extensive table-lands along their sides. For intermediate cases, intermediate numbers must be adopted.

21. Before the publication of the admirable observations of Humboldt, it was usually assumed, in speculations respecting the line of perpetual snow, that it coincided with that of 32°. Later observations have shown the error of this hypothesis, especially in the higher latitudes. Humboldt has given the following results, deduced from his own observations and those of others, respecting the mean annual temperature at the limit of perpetual snow, in different latitudes:

At Chimborazo, lat. = 1°·28′ S.	Mean temperature of the snow-line	=32°+ 2°·7=34°·7 F.
At St. Gothard, lat. = 46° N.	" "	=32° - 6°·7=25°·3
At the Polar Circle	" "	=32° −10°·8=21°·2

Hence it follows that near the equator the snow-line is nearly 1000 feet lower than that of 32°, while at St. Gothard it is higher than this latter line by about 2000 feet, and at some places on the polar circle by about 3500 feet, according to Humboldt. But in that latitude in the northern hemisphere the height of the snow-line above that of 32° appears to be very variable, as might be expected from the very different conditions under which different regions are situated along the same parallel of latitude. In north-eastern Asia it is probably much greater than 3500 feet, while in Iceland the two lines must nearly coincide.

I am not aware of other similar observations on the temperature of the snow-line, or on the relative heights of that line and of the line of 32°. The height of the snow-line, however, has been ascertained in several other places, and the height of the line of 32° F. may be calculated, and their relative positions determined. Thus for the Pyrenees (lat. =42° 30′) we have by observation,—

Height of snow-line . . . . =9300 feet.

The mean annual temperature at the level of the sea may be taken at 56°, and therefore the decrease up to the line of 32° will be 24°; and, allowing 320 feet ascent for a decrease of 1° F., we shall have,—

Height of the line of 32° . . . . =7680 feet.

Consequently the height of the snow-line will exceed that of the line of freezing temperature by 1620 feet.

A similar calculation for the Caucasus (lat. 42° 30′), where the height of the snow-line is rather more than 10,000 feet, gives the height of the line of 32° less than 8000 feet, and therefore lower than the former by about 2500 feet. And again, for the Himalaya we have similar results. On the south side of this range, in latitude 32° N., we may take the mean annual temperature, independently of elevation, at 67° F., or 35° above the freezing temperature, and, allowing 400 feet for a decrease of 1° F. in ascending the southern slope of the mountains (§ 20, p. 248), the height of the line of freezing temperature will be 14,000 feet. The height of the snow-line, as given by Captain Strachey, is there 16,000 feet, or 2000 feet higher than the former line. On the north side of the range, allowing 2° F. in the mean annual temperature, independent of elevation, for the difference of latitude as compared with the south side, and 480 feet of ascent for each degree of temperature (§ 20), we have 15,840 feet for the height of the line of 32°. Also we have, on the same authority as the above, the height of the snow-line 18,500 feet, or upwards of 2600 feet above the former line.

These calculated results as to the difference of heights of the snow-line and that of the temperature of 32° may not of themselves be entitled to much confidence, compared with those deduced from observation; but they show that the data on which the calculations are founded are in accordance with the results of observation in other cases.

22. It appears from the preceding facts, that the height of the snow-line, with reference to the line of 32° F., increases, under similar conditions, as we proceed northward from the equator. For this phenomenon we may assign two principal causes, which

it is important for us to notice, in order that we may be able the better to understand the real analogies between actual cases of observation and the hypothetical cases of past geological epochs.

At places near the equator, and especially at great elevations, there is little variation of temperature from one season to another. Let us suppose a case in which the temperature should be entirely equable. The snow-line would be absolutely stationary. Above this line the snow would tend to accumulate by constant deposition, until this tendency should be exactly counteracted by destructive causes, such as the direct action of the sun's rays, evaporation, drifting by the wind, avalanches, &c. The snow-line would be that beneath which these antagonistic causes would cease to be in equilibrium, and its position would manifestly depend *cæteris paribus* on the quantity of snow produced in the atmospheric region directly over that upper portion of the mountain which should be bounded by the snow-line. If the quantity of snow thus formed and falling on the mountain should be very small, the destructive causes would not allow it to remain permanently at so low a level as that of the line of freezing temperature, which might in this case be considerably below the snow-line. On the contrary, if a comparatively large quantity of snow should fall on the mountain, the snow-line might descend to a considerable distance below that of freezing temperature.

But let us now suppose the annual temperature to vary from summer heat to winter cold, the *mean* annual temperature remaining the same. It is manifest that the variable snow-line during the year would in winter be below, and in summer above the permanent snow-line of the previous case, the extent of this oscillation being proportionate to that of the temperature during the year. But the highest or summer position of this variable snow-line is what is properly called *the snow-line.* Thus, while, with a temperature in which the variation from summer to winter should be comparatively small, the snow-line should be below the line of freezing temperature, it might be far above that line if the oscillation of temperature were great, although the *mean* annual temperature should be the same in both cases.

Considering then the position of the snow-line with reference always to the line of 32°, the conditions which produce its lowest positions are those which secure a moist atmosphere with an approximately equable annual temperature. Comparing places in the same latitude, an insular position will have a lower position of the snow-line than a continental one. In comparing a place near the equator with one in the higher latitudes, there will be much greater humidity in the atmosphere and much less variation in the annual temperature in the former case than in the latter, and both these causes tend to produce a much lower position of the snow-line, with reference to the line of 32°, in the former case than in the latter. These general causes, independently of the action of mere partial causes, are sufficient to explain the general results of observation above given.

23. After the preceding considerations respecting the relative positions of the line of 32° F. and the snow-line, I proceed to examine the distances, measured vertically, to which the principal known glaciers descend below this latter line, which forms the limit of a glacier's superficial increase. Such distance must depend on the depth of the glacier, the rate of its motion, and the activity of the destructive agencies to which it is exposed. It is of course widely different for glaciers of different magnitudes, but for those which are sufficiently large to be considered of the *first order*, it varies much less than might perhaps be expected, as appears from the following table. The glaciers specified are all of the first order in magnitude, except, perhaps, that of the Maladetta.

	Latitude.	Height of snow-line.	Names.	Height above the sea.	Ht above snow-line.	Name of glaciers.	Heig't of low'r end of glac'r.	Descent below sn'w-line
		feet.		feet.	feet.		feet.	feet.
Pyrenees,	42° 30′	9300	La Maladetta	11,300	2,000	Gl. de la Maladetta	7,600	1,700
Caucasus,	42 30	10,300	Kasbek	15,000	4,700	Desdaroki	6,400	3,900
The Alps,	45 50	9000	Mass of Mont Blanc	13,300	4,300	Gl. des Bois	3,700	5,300
			Mont Blanc	16,000	7,000	Gl. des Bossons ...	3,700	5,300
						Gl. de la Brenva ..	4,500	4,500
	45 30	8800	Mass of the Grindelwald Mountains.	Mean, 13,300	4,500	Gl. de Grindelwald	3,500	5,300
						Gl. d'Aletsch	4,500	4,300
						Gl. de l'Aar	6,150	2,650
Scandinavian Fjelds,	61 43	5500	Summit of Lodalskaabe	6,800	1,300	Gl. of Lodalskaabe	1,700	3,800
			Plateau of Justedal	6,000	500	Gl. of Nygaard ...	1,100	4,400
						Gl. of Berset	1,500	4,000

The Table is extracted from the memoir of M. Durocher, in the *Annales des Mines*, 4 sér. tom. xii, 1847.

It will be observed that the descent of the Aar glacier below the snow-line is considerably less than that of any other equally large glacier enumerated in the above table. This I conceive to be due to the very small inclination of the bed of that glacier towards its lower extremity. If we reject this example as anomalous, the mean descent of the remaining nine great glaciers below the snow-line is about 4500 feet.

There are also three glaciers in the Himalayas, from the extremities of which the Pindur, the Gori, and the Ganges issue. The heights of these sources have been incidentally given by obervers,* as being respectively 11,946, 11,543, and 13,500 feet. Taking Capt. Strachey's estimate of the height of the snow-line

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* See Captain Strachey's Paper "On the Snow-line in the Himàlaya," Journ. Asiatic Soc., Bengal, April, 1849; and Edinb. New Phil. Journ., vol. xlvii, 1849; and "On the Physical Geography of the Provinces of Kumàon and Garhwàl," Journ. R. Geograph. Soc., 1851.

as 16,000 feet in that region, we have 4054, 4457, and 2500 feet for the descents of these glaciers below the snow-line. The two former are in very near accordance with the mean of the cases above given; the last more nearly accords with the smaller descents of the glacier of the Aar, and is probably due to a similar cause.

The glaciers which proceed from more limited spaces for the accumulation of snow and ice descend below the snow-line to distances much shorter than those above given.

2. *Height of the Snow-line, and Descent of Glaciers below it in the hypothetical cases of* § I.

The degree of cold requisite to produce glaciers on a mountain might obviously be caused by the elevation of the mountain. I shall, in the first place, suppose former glaciers in western Europe to have been due to this cause alone, and determine the general elevation of that region which would be necessary to produce such effects, rejecting the supposition, as altogether improbable, that each individual mountain which exhibits glacial phenomena was locally elevated independently of any corresponding elevation of the surrounding region. I shall then proceed to the hypothetical cases of the previous section.

24. The present mean annual temperature of the Alps may be taken at 55°·5 F. (§ 13, p. 77), or 23°·5 above the freezing temperature. The height of the snow-line is about 9000 feet, and that of the line of 32° F. about 7000 feet, which gives a decrease of 1° F. for about 300 feet. If the surrounding region should be elevated several thousand feet together with the Alps, we may take the decrease of temperature for 1° from the level of the sea for about 400 feet (§ 20, p. 249). This would give the height of the line of 32° above the level of the sea, after the elevation, equal to about 9300 feet; and assuming the height of the snow-line to exceed this, as at present, by 2000 feet, the height of that line would be 11,300 feet. It is probable that the glaciers would not in this case descend quite so far below this line as at present. Suppose them to descend 4300 feet below it; the height of their lower extremities would then be about 7000 feet above the level of the sea. Consequently the glaciers would descend into the level of the lake of Geneva, provided the elevation of the region placed that lake 7000 feet above the sea, or about 6000 feet above its present level.

Hence, if blocks on the Jura have been transported from the Alps by the agency of ice, the Alps must, according to our present hypothesis, have been at least 6000 feet higher than at present, supposing the surrounding region to some extent to have been elevated at the same time.

The present mean annual temperature of Snowdon is about 49°·5 F., or 17°·5 above the freezing temperature. Assuming the general elevation of western Europe, Snowdon would stand on a wide elevated table-land, and we may take the decrease of temperature at 1° F. for about 450 feet.* This would give the height of the line of 32° equal to rather more than 7800 feet, and, supposing the snow-line 2200 feet higher, we have 10,000 feet for the height of this latter line. Now to produce glaciers of considerable magnitude on Snowdon, its summit must probably rise some 1000 feet above the snow-line, or to the height of 11,000 feet. Hence the whole region must be elevated between 7000 and 8000 feet above its present level. The glaciers might then be expected to descend to the table-land at the foot of the Snowdonian mountains, *i. e.* about 2000 feet below the snow-line. Further descent to any extent would be prevented by the comparatively horizontal surface of the immediate foot of the mountains.

In higher latitudes the required elevation would be smaller; but speaking generally, in order that glaciers should exist on our present mountains of sufficient magnitude to descend down to their present bases, in consequence of a general elevation of western Europe, it would be necessary that that region should be raised into an elevated range from the polar circle to the south of the Alps, rising in some parts to the height of 10,000 or 12,000 feet.

25. I shall now take the case in which the old and new continents are supposed to be united by the conversion of the basin of the Atlantic into land. We should have, according to the estimate above given (§ 15, p. 80), the mean annual temperature of the Alps about 44°·5 F., or 11° lower than at the present time. The position of the line 32° F. would therefore be lowered by about 3500 feet, but the distance of the snow-line above it would be much increased by both the causes which appear chiefly to influence that distance. The oscillation of temperature from January to July, would be 61° F. instead of 34° as at present, and the quantity of snow falling during the year would doubtless be much diminished by the entire absence of sea in the surrounding region. It would seem probable that the position of the snow-line would be as much raised by these causes, as it would be lowered by the diminution of temperature. Moreover, it is probable, that the glaciers would not descend so far below the snow-line as at present, on account of the diminution of their mass, arising from the diminished quantity of snow. I conceive it probable, therefore, that the Alpine glaciers would not descend, in the case now contemplated, to points less elevated

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* I take this number greater than for the Alps, because the elevation of the surrounding region would in this case form a higher table-land than that immediately around the Alps.

than at present above the level of the sea. In such case it would be necessary to give to the Alpine region about the same additional elevation as in the former case (§ 24) in order that the glaciers should descend to the lake of Geneva.

The mean annual temperature of Snowdon would be nearly 30° F., and the isothermal of the mean annual temperature of 32° would pass through the mountains of the southwest of Ireland which present many indications of former glaciers. Along this isothermal, the line of 32° F. would coincide with the surface of the earth, and the height of the snow-line above it would be identical with the absolute height of that line, which would therefore be about 2500 feet, if the distance between these two lines should be the same as at present. For the reasons assigned, in the preceding paragraph, this distance, however, would undoubtedly be much greater than at present. The oscillation from winter to summer temperature would amount to no less than 73° 5′ F. (§ 15), whereas it is at present only 23°. The present distance, therefore, between the two lines in question being taken at about 2500 feet, it is probable, I think, that in the case now considered, it would not be less than two or three times that quantity. And this conclusion appears to be in accordance with the knowledge we possess of the Altai mountains in the northeast of Asia. Those mountains rise to the height of 9000 or 10,000 feet, and the mean annual temperature is under 32° F.; and yet, as I am assured by that distinguished traveller, M. de Tchihatcheff, there are no glaciers upon them of any magnitude, a sufficient proof that the snow-line cannot in all probability be lower than the above estimate.

In proceeding farther to the north, the snow-line would probably meet the level of the sea about the latitude of the northern part of Scotland. In all higher latitudes the surface of the earth would be covered with perpetual snow.

It follows, then, that if the Atlantic were converted into dry land, it would still be necessary, in order to obtain glaciers to the extent required by observed phenomena, that the western part of Europe should be elevated into a range extending nearly from the 40th to the 60th parallel of latitude, and higher than the present surface by some 4000 or 5000 feet.

26. I now proceed to that which I consider by far the most important of our hypothetical cases,—that in which we assume the absence of the Gulf-stream and the submergence of a large portion of northern and central Europe beneath the ocean. There is no difficulty in this case in accounting for the existence of glaciers in the northern parts of Scotland and in more northern latitudes; but it is necessary to consider carefully how far the conditions of their existence in the more southern latitudes in which traces of glacial phenomena are observed, could be fulfilled. I will first consider the Snowdonian region.

Let us suppose Snowdon and the surrounding country lowered 500 feet below its present level. If the whole of Europe were depressed to the same amount, a large portion of it would be submerged beneath the ocean; but we are at liberty to suppose any part of it depressed to a greater amount, if necessary to produce the more complete submergence here assumed. I have estimated the most probable mean annual temperature of Snowdon at 39° or 40° F., in the absence of the Gulf-stream (§ 13, p. 77) and of any cold current from the north; and I have also shown that it would be little altered by the submergence of Europe beneath the sea (§ 18, p. 85). This would give the height of the line of 32° F. equal to at least 2200 feet, or about 800 feet below the summit of Snowdon in its depressed position. In estimating the position of the snow-line with reference to the line of 32° F., it must be recollected that the region about Snowdon would form a group of small islands in the midst of an extensive ocean, and would so far be under conditions favorable for producing a moist climate and a low position of the snow-line relatively to the line of 32° F. I have already (§ 18) referred to Iceland and the island of South Georgia as furnishing cases similar in conditions to this hypothetical case of Snowdon. Their insular positions and mean annual temperatures are nearly the same as in that case. The difference of summer and winter temperature, however, would be greater for Snowdon than for either of the other cases, being about 14° for S. Georgia, 20° for Iceland, and between 30° and 40° for Snowdon. These considerations would lead us to conclude that the height of the snow-line, with reference to the line of 32° F., would be somewhat higher on Snowdon than in the other two cases. The height of Snæfell Jokul, on the northwest coast of Iceland, is, according to Makenzie, 4558 feet, and that of the snow-line upon it 2734 feet, as measured by Sir J. T. Stanley. The mean annual temperature there is about 38°, and consequently the height of the line of 32° must be about 2000 feet, upwards of 700 feet below the snow-line. On the south coast of Iceland the mean annual temperature is about 40°, and the height of the line of 32°, consequently, less than 3000 feet. The height of Eyafialla Jokul is about 5500 feet, and the height of the snow-line is probably much the same as at Snæfell. The glaciers there are stated to descend nearly to the level of the sea.

I have estimated the mean annual temperature of the island of S. Georgia at 38°. Consequently, the line of 32° will be at about the elevation of 2000 feet. It is very desirable that more accurate observations should be made on the height of the snow-line in that island than, I believe, have hitherto been obtained. The vague assertion that the snow-line there descends to the level of the ocean, has probably arisen from confounding that line with the level to which the glaciers descend. All we seem to know is, that glaciers descend to the margin of the sea; but before we can reason conclusively on this, as a case analogous to that of Snowdon or of other mountains in our own islands, it is necessary to know more than I have at present been able to ascertain, respecting the height and configuration of the mountains from which the glaciers descend. Mr. Darwin in his Journal quotes Cook's description of the island, but it contains no accurate information on the points in question, although it would lead to the inference that the snow-line must be considerably below the line of 32° F.

It would seem very possible then, that the snow-line on Snowdon in the present hypothetical case might not be higher than the line of 32° F., the height of which is above estimated at 2200 feet. Glaciers might thus descend from a snow-line little more than 2000 feet high to the level of the sea.

27. If, in addition to the hypothesis of the absence of the Gulf-stream, we adopt that of a cold current from the north, sweeping over the submerged portions of northern and western Europe, we shall have an additional cause which might probably lower the mean annual temperature of Snowdon and the neighboring region by 3° or 4° below that above assumed. Such a current would also tend to equalize the summer and winter temperatures, since its effect would there be principally or entirely produced on the summer temperature, which might possibly be lowered 6° or 8°. The snow-line would thus be brought at least 1000 or 1200 feet lower than above supposed. This would be sufficient to account for glaciers descending to the sea, not only on Snowdon, but also on the lower mountains of the west of Ireland.

28. Conclusions, but somewhat vague, have been drawn respecting the former possible existence of glaciers in western Europe, from the actual existence of glaciers descending to nearly the sea-level in South America, in comparatively low latitudes. But in this comparison the relative heights of the mountains in the two regions has been frequently, I think, overlooked. In the case we have been discussing, the mean annual temperatures in corresponding latitudes in the two hemispheres would be almost exactly the same, and probably the quantity of moisture in the atmosphere and the quantity of snow in similar positions might be much the same; but the greater extent of land which must have existed in the northern hemisphere, as compared with the southern, in the more recent geological periods, must have rendered the summer temperature greater in the northern than in the southern hemisphere, and consequently the snow-line and, *cæteris paribus*, the lower extremities of the glaciers somewhat higher in the former than the latter region. The great distinc-

tion, however, between the western coast of South America and that of Europe consists in the great difference in the heights of their mountains. A glacier is described by Mr. Darwin* as descending to the sea-level in the Gulf of Penas, on the west coast of South America, in latitude 46° 40′. According to Dove's map, we have for that place—

July temperature, ...	40° F.
January temperature, . . .	50
Mean annual temperature, . . .	45

Hence the height of the line of 32° must be about 4500 feet. The difference between the January and July temperatures is only 10°, the latter being considerably reduced by the cold current passing round Cape Horn. This, with the proximity of the Pacific, is highly favorable to a low position of the snow-line. It may probably lie near the line of 32°, or even considerably lower, in which case the glacier must descend between 4000 and 5000 feet below it. This coincides with the distances to which almost all glaciers of the first order descend below the snow-line (§ 23, p. 252) and presents nothing anomalous. It is described as a very large glacier, descending from a lofty mountain, which rises, undoubtedly, many thousand feet above the snow-line. It is in this respect that the analogy between the glaciers of South America and those which may have formerly existed on such mountains as those of the British Islands entirely fails. With the same climatal conditions, we might have glaciers descending to the sea-level in the one case, without a trace of glaciers in the other.

29. I shall now discuss the case of the Alps. Adopting the hypothesis of a current from the north, it is manifest that such a current would, as already remarked, tend much to equalize the temperature from the latitude of Snowdon to that of the Alps in the present region of western Europe, precisely as the Gulf-stream now equalizes in so remarkable a degree the temperatures of different latitudes in a considerable portion of its course in the northern ocean. If we assume its effect on the mean annual temperature of the Alpine region to be 8° or 9°, instead of 3° or 4°, as in the Snowdonian region, we shall probably not overestimate its influence. The mean annual temperature would be thus reduced to about 45°. The height of the line of 32° would then be about 5000 feet. The difference of summer and winter temperatures would be considerably less than at present, and the position would approximate much nearer to the character of an insular one. Both these circumstances would be favorable to a lower position of the snow-line with reference to the line of 32°, than at present, and the latter also to the production of snow.

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* Darwin's Journal, p. 284.

Under such circumstances glaciers might descend to the sea-level, where the configuration of the mountains should be sufficienly favorable to their descent, and supposing the sea to stand at such a relative height as to reach the bases of the mountains. That this was the case, I have little doubt; for with the conviction that an enormous erratic block like the *pierre à bot*, above Neufchatel, must have been transported across the valley of Switzerland by floating ice, I think it most probable that the whole Alpine region was, at the glacial period, 2000 or 3000 feet at least lower than its present level; so that the sea might not only extend to the base of the Alpine range, but might also penetrate into many of its lower valleys.

Thus it appears from this investigation, that the same conditions which would produce glaciers on our Welsh and Irish mountains, descending to the level of the sea from a snow-line from 1000 to 1500 feet above that level, might also produce similar phenomena in the Alps with a snow-line 5000 or 6000 feet above the sea. In more northerly regions there would, of course, be no difficulty in accounting for the existence of similar glaciers.

(*To be continued.*)

[Note.—The Map which we have added to this volume in illustration of Prof. Hopkins's paper, is a copy of one of the isothermal charts of Dove—that for January; except that we have made it throughout a winter chart by substituting for the January lines south of the equator the July lines, July being midwinter in the Southern hemisphere. The positions over Europe and the Atlantic of the lines of 32°, 23° and 14° in Prof. Hopkins's hypothetical cases, are shown by interrupted lines connecting Dove's lines (the dotted lines) of the same name.—Eds.]

Art. XXXI.—*Brief Characters of some New Genera and Species of Nyctaginaceæ, principally collected in Texas and New Mexico*, by Charles Wright, Esq., under the direction of Col. J. D. Graham, U. S. Topogr. Engineers, late Chief of the Scientific Corps of the Mexican Boundary Commission; by Asa Gray, M.D.

ACLEISANTHES, Nov. Gen.

Involucrum nullum. Perigonium tubulosum vel tubæforme, limbo patulo 5-angulato. Stamina sæpius 5, inclusa. Stylus mox exsertus: stigma peltatum læve. Fructus ovoideus vel cylindraceus, 5–10-costatus. Embryo conduplicatus, albumen farinosum includens; cotyledone interiori minore.—Herbæ radicibus tuberosis; caulibus decumbentibus vel diffusis; foliis oppositis petiolatis; floribus albis vel albidis solitariis (raro geminatis) terminalibus vel pseudo-axillaribus subsessilibus bracteolis 2 subulatis parvis subtensis.

A genus principally distinguished from Mirabilis by the want of an involucre; whence the name. From Nyctaginia, with which Choisy confounded one species, it abundantly differs in its solitary or subsolitary and sessile flowers, destitute of an involucre, unless the pair of minute subtending bracts be so called, and in the included filaments. In this, as in most Nyctagineous genera, a portion of the flowers, especially the earlier ones, are precociously fertilized in the bud, while the perigonium is yet small; when the latter, being arrested in its development by the growth of the fructifying ovary, never expands.

1. Acleisanthes crassifolia (sp. nov.): scabro-puberula; caulibus decumbentibus; foliis crasso-coriaceis ovatis basi rotundatis mucronatis: tubo perigonii limbo ter quaterve longiore; fructu ovoideo vix costato.—High prairies of San Felipe Creek, W. Texas; July, 1849. (No. 599, coll. *Wright.*) Tube of the expanded flower, one and a half to two inches long; in the precociously fructified flowers much shorter.

2. Acleisanthes longiflora (sp. nov.): glabra; caulibus basi suffruticosis divaricato-ramosissimis deltoideo-ovatis summisve rhomboideo-lanceolatis acuminatis margine undulatis; tubo perigonii prælongo gracili (5–6-pollicari); fructu cylindraceo 5-angulato.—Valley of the Limpio; and near San Antonio, Texas. (*Wright*, No. 599.) Stony hills of the Pecos, May. (*Wright*, No. 1704.) Also collected in Texas by *Prof. Riddell* and by *Mr. Lindheimer;* and in Northern Mexico by *Dr. Gregg.*—Leaves variable in shape, about an inch long. I have seen little mature fruit, and no precociously fructified flowers.

3. Acleisanthes Berlandieri: glabra, diffusa; foliis cordatis reniformibus ovatisve obtusis vel acutis parvis; tubo perigonii limbo duplo triplove longiore.—Nyctaginia obtusa, *Choisy in DC. Prodr.* 13, *p.* 429.—Corpus Christi, and on the Rio Grande, Texas. Between the Rio Frio and the Nueces, Texas, *Berlandier.* Near Monterey and Matamoras, *Gregg.*—Leaves a third to two thirds of an inch in length, not including the slender petiole, variable in shape. Flowers white, tinged with purple in fading, as in all the species. Fruit unknown.—Choisy describes the leaves of his Nyctaginia obtusa as "cuneate-oblong, obtuse at both ends;" but a rude sketch which I made from the original specimen, in the Candollean herbarium, exhibits them as rounded-cordate, or somewhat reniform. I doubt not, therefore, that it is the plant here characterized, although other points in the character are more or less at variance with my incomplete specimens. No. 1705 of Wright's collection, from hills between the San Fe-

lipe and the Pecos, may belong to this species; but it is as likely to be a depauperate state of the preceding. These specimens have no developed flowers.

4. Acleisanthes anisophylla (sp. nov.): glabella, humifusa; foliis ovalibus seu ovatis basi obliquis vel oblique subcordatis in eodem pari valde inæqualibus, altero nunc fere abortivo; tubo perigonii evoluti limbo pluries longiore; fructu 10-costato.—Prairies of Turkey Creek and Elm Creek, W. Texas, May. (*Wright*, No. 598, 1706.)—Leaves somewhat resembling those of Allionia incarnata, especially the glabrous variety, but much more unequal; the larger one of each pair an inch or an inch and a half long, on a petiole of three or four lines in length; while the smaller one is never longer than the petiole of its fellow, in the lowest cauline, and the latest rameal pairs sometimes obsolete or nearly so. The full-grown flowers are an inch and a half to two inches in length; the precociously fertilized ones much smaller. I have seen the fruit only from the latter, and that not fully formed: it is fusiform, or ovoid-oblong, and only two lines in length.

PENTACROPHYS, Nov. Gen.

Involucrum e bracteolis 3 subulatis, florem solitarium subsessilem fulcrans. Perigonium (perfectum ignotum,) florum in alabastro præcoque fecundatorum tubulosum, breve. Stamina 2. Stigma peltatum læve. Fructus cylindricus, truncatus, 5-costatus, costis crassis suberosis apice glandula magna umbonatis. Embryo conduplicatus, albumen farinosum includens; cotyledone interiori minore. Herba humilis, e radice lignescente multicaulis, diffusa, viscoso-pubens, scabrida; foliis oppositis petiolatis ovalibus; floribus axillaribus et terminalibus parvulis.

Pentacrophys Wrightii.—Stony prairies at the Big Bend of the San Pedro River, and between the Pecos and the Limpio, on the route between Texas and El Paso; May, June, (*Wright*, No. 1713.) Cultivated in the Cambridge Botanic Garden, it produced a succession of flower-buds during the summer and autumn, all of which were precociously fertilized, but not a single flower attained its full development. The indigenous specimens also bore abundance of fruit, the younger surmounted by the undeveloped perigonium, but no expanded flowers were seen. From analogy, however, such may be expected to occur. In one instance, two flowers were detected in the same involucre, if such the three small bractlets may be termed. The fruit is three or four lines long; its very thick ribs leave only narrow grooves between them. The superficial tissue of these ribs abounds in tubular cells, containing a spirally coiled thread, which is usually disengaged upon the application of moisture. Dr. Torrey has remarked to me that this structure is found in most Nyctaginaceæ except Pisonia. The position of this genus is evidently between the preceding and the following.

SELINOCARPUS, Nov. Gen.

Involucrum nullum. Perigonum (perfectum) cyathiforme, vel infundibulari-tubulosum, limbo 5-angulari. Stamina 2 seu 5, mox exserta. Stylus filiformis: stigma peltatum læve. Fructus 5-alatus (vel abortu 3–4-alatus), alis scariosis aveniis. Embryo conduplicatus, albumen farinosum includens; cotyledone interiori minore. Herbæ humiles (vel suffruticuli), e radice tuberosa seu lignescente multicaules; foliis oppositis subinæqualibus alternisve petiolatis; floribus terminalibus vel pseudo-axillaribus sæpius geminatis vel fasciculatis; bracteolis 1–3 subulatis minimis seu abortivis.

The fruit of these plants much resembles that of certain Umbelliferæ, such as Cymopterus and Selinum (whence the name). Much of it is produced from flowers precociously fertilized in the bud, as in all the allied genera. Besides the two subjoined species, there is one with suffruticose stems in the late Dr. Gregg's Mexican collection; but my specimen is too imperfect for description.

1. Selinocarpus diffusus (sp. nov.): pube hirtella subviscosa scaber; caulibus ramosissimis depressis vel patenti-diffusis; foliis ovatis seu ovato-oblongis obtusis; floribus sæpius geminatis subsessilibus; tubo perigonii evoluti elongato (sesquipollicari); staminibus 5.—Rocky hills and valleys from the Pecos to the Limpio; May, June. (*Wright*, No. 1708.) In foliage and habit the plant is not unlike Allionia incarnata, but it is more branched and tufted. The flowers, when geminate as well as when solitary, are each subtended by 2 or 3 small and subulate bractlets, which therefore do not properly represent an involucre. The unopened perigonium of the precociously fructified flowers, which usually persists until the fruit is ripe, does not exceed a line in length; while the fully developed flowers are an inch and a half long. The fruit from the two kinds of flowers is just the same: it is three lines long, broadly oval in circumscription, including the wings, which are as wide as the body. These are entirely veinless, and almost wholly consist of parallel, very long and filiform cells, which, on being torn asunder in water, emit attenuated gelatinous threads.

2. Selinocarpus chenopodioides (sp. nov.): pulverulento-puberulus, subcinereus; caule erecto ramoso; foliis late ovatis nunc subcordatis repandis longe petiolatis demum glabratis; floribus cymuloso-fasciculatis pedicellatis parvis; perigonio etiam evoluto brevi, cyathiformi, tubo subnullo; staminibus 2.—Valleys from Providence Creek to the Rio Grande, New Mexico; also near

Lake Santa Maria, Chihuahua; April, June. (*Wright*, No. 1707.) Stems nearly a foot high. Leaves often alternate, twice the size of those of the preceding species, whitened, at least when young, with an apparently farinose fine pubescence, somewhat as in a Chenopodium. Flowers pretty numerous in terminal and alar, cymulose clusters. Bractlets minute and solitary, or none. The expanded perigonium barely two lines in length. Fruit nearly as in S. diffusus, but slightly obovate in outline. Embryo as in Pentacrophys and Acleisanthes.

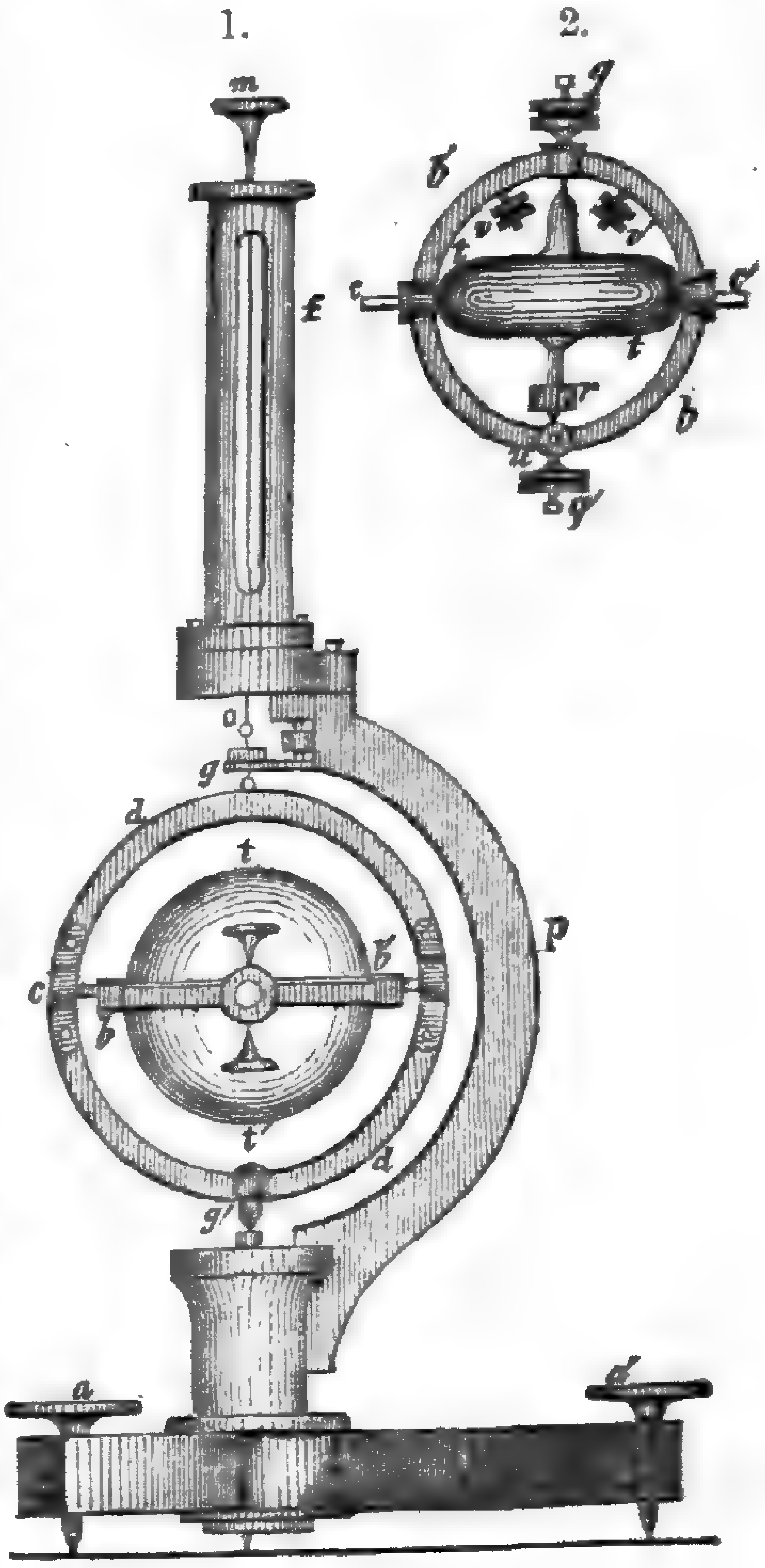
(*To be continued.*)

SCIENTIFIC INTELLIGENCE.

I. Correspondence.

Correspondence of M. J. Nicklès, dated Paris, January 9, 1853.

Foucault's New Method of exhibiting by experiment the Rotation of the Earth.—Among the subjects brought before the Academy of Sciences within the two years past, none has excited more general interest than certain new properties of revolving bodies and the relations of these properties to the rotation of the earth. Several reclamations of priority have followed the first announcement of the discovery in September of 1851; M. Person, M. Foucault, M. Sire, M. Hamman and M. Lamarle, were all occupied with the subject and had arrived at interesting results. Leaving unsettled the question of justice to each of these physicists, we give a description of a new instrument constructed by M. Foucault, by which he establishes the property first announced by him before he knew of his rivals.—*t*, *t′*, (fig. 1,) is a torus of bronze, poised on its axis by means of screws adapted to adjust the center of gravity so as to make it coincide exactly with the center of its figure. The axis of the torus is of tempered steel, ending in two conical points, retained, by slight friction, by the extremities of two screws, *q*, *q′*, (fig. 2,) which act in place of pivot-holes. On the axis of the circle there is a pinion, *r*, which can interlock with the teeth of a wheel intended to give the circle a rapid revolving



motion, equal to 150 turns a second. It is unnecessary to describe the apparatus for producing this motion, as any apparatus will answer that can be adapted to the pinion and will give the requisite rapidity. The center of the torus is occupied by a thin disk which carries a plate of glass with parallel surfaces or a metallic mirror, by means of which, the exact plane of rotation of the moving object can be observed through the reflection of a distant mark. The torus and its axis are supported by a cylindrical ring b, b', (figs. 1 and 2,) one of the diameters of which is occupied by the axis of the torus. In this ring are the conical pivot-holes, q, q', in which the two points of the axle of the torus can play and be more or less restrained in their movement. Above the screws with pivot-holes, the ring carries the vertical screws, u, u', which in connection with the other horizontal screws, v, v', serve to adjust the whole in equilibrium when supported on the knife blades of tempered steel, c, c', which are on the exterior part of the ring at the extremities of the diameter perpendicular to that which contains the axis of rotation of the circle. These knife edges are made to rest on two agate plates on a third ring, d, d', (fig. 1,) the exterior member of the system.

The apparatus is brought into exact equilibrium, with the knife blades perfectly level whatever position be given the torus in its revolution; the ring which carries it always remaining horizontal, so that, like the beam of a delicate balance, the slightest addition on one side or the other will cause it immediately to dip accordingly. The exterior ring is so placed that the agate plates are in its horizontal diameter while its vertical diameter contains the arrangement for suspension. This arrangement consists of a hook o, on the upper side of the ring for attaching a thread of untwisted silk; this silk thread is protected by a vertical tube (f, fig. 1) and is attached to a thumbscrew m, which serves to raise or let down the ring a little, as may be needed.

The piece which carries the hook passes through a double piece, g, whose upper part acts in fixing the ring in its position; but there is no friction as the object is only to prevent a pendulum movement in the ring. On the lower side, this ring carries a conical point, g', which moves in a pivot-hole without touching, the object of which like the part g, is simply to prevent a swinging motion.

This apparatus is supported by a semicircle, p, having a foot with thumbscrews, a, a', for making it horizontal, so as to place the thread and the large ring in a perfectly vertical plane.

The torus and its ring may be easily taken out from the outer circle to be adjusted to the apparatus employed for setting the torus in rotation; at the moment this rotation is obtained, the whole system is replaced in the outer circle, when the phenomena due to the fixedness of the plan of rotation soon become apparent.

For the purpose of measuring the *apparent* motion of the great circle (or rather the *actual* motion of the observer) a large ring graduated to degrees, minutes, etc., is made to surround the apparatus, at a level with the knife blades; and there is a microscope having a fixed wire adjusted to the eye-piece, for reading the smallest divisions. In this way the angular movement of the circle is easily shown to be proportional to the sine of the latitude.

If in place of putting the knife blades on the agate plates, we insert the points of the screws, q, q', which carry the axis of the torus, by which all movement of inclination in the inner circle is prevented, we perceive at once a movement of orientation in the apparatus by which the great circle places itself with the plane of rotation of the torus in the prime vertical, while the axis of the torus is arrested in the plane of the meridian of the place. But if the inner circle is replaced on its knife edges, and the outer is then fixed in the direction of the prime vertical by means of the screw q', while the axis of the torus is on the meridian, we see at once the inner circle become inclined, and finally parallel to the axis of the diurnal rotation of the earth, so that the direction of the movement of the torus is the same with that of the diurnal rotation.

This apparatus M. Foucault calls a *gyroscope*, and by its aid we may find the pole, and the east and west points, determine the latitude of a place, and study the rapidity of the earth's motions, without recourse either to astronomical observations, the magnetic needle, or a pendulum. The apparatus has been admirably constructed by M. Froment. Other capable mechanicians had given it up; but it proved mere play to this distinguished artist who has so largely extended the limits of precision in philosophical instrumebts. We shall more than once entertain our readers with the apparatus, and especially, the electro-magnetic machines of M. Froment. Everything connected with electricity is manufactured in his establishment, and it is a treat to gain access to his private apartments where there are all kinds of electro-magnetic machines, and among them some whose electro-magnets make 12,000 inversions per minute.

Influence on Astronomical Observatories of vibrations produced by vehicles passing on roads, and other causes.—The Paris Observatory is surrounded by roads in constant use, day and night. A railroad (the line to Sceaux) is near by. The vibrations produced by vehicles on these roads, have for a long time been observed, and they have interfered with their observations, especially those made with the aid of reflection from a mercury horizon. These difficulties, which have been felt by all astronomers who have observed in circumstances like those of Paris, came under the consideration at the same time of M. Mauvais, of the Paris Observatory, and M. Séguin, Sr. The latter, the illustrious inventor of tubular boilers, is now retired from his honorable labors, in a small but elegant observatory constructed at the centre of the buildings of the old abbey of Fontenay, near Montbard, and close to a paper manufactory, the movement of whose cylinders caused his artificial horizons of mercury to vibrate, and produced oscillation in the star reflected in the field of the telescope. While these astronomers were planning, unbeknown to one another, a method of overcoming these difficulties, M. Mauvais happened to pass by Montbard, and meeting M. Séguin, mentioned to him his project; and since then they have been united in their endeavors, and have hit upon an extremely simple means of protecting the mercury from external vibrations. The method is to take a strap of vulcanized caoutchouc, fold it double and fix in the fold, that is, at the middle of the band, the stand which supports the mercurial horizon; then attach a cord to each end of the strap and fasten it to the ceiling. It is essential to success that the mercury should not be so heavy as to injure the elasticity of the strap, or subject it to its maximum of tension. Messrs. Seguin and Mauvais have thus secured good results with the caoutchouc band; they have found that in order to extinguish the vibrations indicated, elasticity by *traction* is preferable to elasticity by *pressure.* The solution of this difficulty will be welcomed by astronomers, and especially by M. Airy, who after having arranged a thick bed of sand in one of the halls of the Greenwich Observatory, for his artificial horizon, still found that it had not the steadiness required by his zenith reflection telescope, an instrument from which he had expected great results.

Tangent Compass.—The accuracy of the indications afforded by the tangent compass has of late been more than once suspected, and quite recently, this instrument has been critically examined by M. Jacobi, who has extended his researches to nearly all the instruments used for measuring the intensity of currents.

M. Despretz has treated this subject profoundly by a series of experiments which the limits of this communication will not allow me to report. The fundamental fact established is that the tangents of the deviations are not necessarily proportional to the intensity of the current, and that they can be considered proportional only when the great circle in which the current passes has a diameter of a meter, and the length of the needle is not under 3 centimeters.

Such large needles will in fact have little sensitiveness; but they may be made as sensitive as small needles, by substituting, for the plate of the great circle, four large wires, 5 to 8 millimetres in section, insulated from one another by being wound with silk.

The tangents of the deviations of this instrument represent the intensity of the currents, and we have thus a true *proportional rheometer.*

If we replace the four large wires by a bundle of twelve to twenty wires of smaller size, (for example, three to four millimeters,) we shall have *proportional rheoscopes*, sufficiently sensitive for measuring the intensity of the feeblest currents. In order that the delicacy of the divided circle should correspond with the precision of the apparatus, it is necessary that the circle should be about 30 centimeters in diameter.

These rheometers and rheoscopes may also be used for graduating ordinary rheometers and rheoscopes.

The formula used by Despretz for the calculation of his results, and which accords with experience, is not the ordinary formula,

$$I = T \operatorname{tang} \theta$$

in which T represents the intensity of terrestrial magnetism, but the more complex formula,

$$I = (1 + 3\alpha^2) \operatorname{tang} \theta - \frac{15\alpha^2}{8} \sin 2\theta$$

which is founded on the theory of Ampere. In this formula, I represents the intensity of the current; θ, the deviation which it impresses on the needle; α, the relation between the semi-distance of the poles of the needle and the radius of the circle of the current.

Self-registering Compass.—M. Deleuil has presented to the Academy a self-registering compass of his construction. Its object is to register the changes of direction in a vessel for every 3 minutes during the 24 hours. The marking is made on a compass-card ; and it enables the captain to control with certainty the direction followed by his ship, and overlook most effectively the maneuvers of the steersman and pilot.

This self-register consists of 3 principal parts ; 1, a clock-movement placed at the center of the apparatus, for causing the point or pivot carrying the needles, to move up and down at regular intervals ; 2, an endless screw, furnished with a nut carrying the point for piercing the paper ; 3, the compass-card made of 3 needles fixed to a sheet of mica, a material as little hygrometric as possible. The mica is covered with a disk of velvet firmly glued to it by means of strong glue, and whose tissue has been saturated by a kind of glue that is soft when cold ; on cooling, the glue has an even surface pierced with an infinity of pores into which the point will readily penetrate after having pierced the paper compass-card. Owing to this addition, the process of puncturing does not stop the movement of the needle, a principle essential to the success of any method of self-registering.

When the needle is fixed towards the north, the axis or diametral line of the compass-card is placed in the line of the axis of the ship, and the punctures, made every three minutes, will indicate the deviation of this axis with reference to the magnetic needle : the succession of points, or the nearly continuous line which they trace, shows to the eye the course of the route.

On Extinguishing Fires by Steam.—After the burning of the Amazon, and Henry Clay, M. Dujardin, of Lille, recalled the fact that in 1837 he proposed to employ steam for extinguishing fires ; as was also mentioned by M. Fourneyron, soon after the disaster of the Amazon. I will add that the process proposed by M. Dujardin has been tried with full success during a fire that occurred in the Galvanoplastic work-shops of MM. Christoffe, at Paris. The fire had already made great progress, and threatened a complete destruction of the buildings before aid could be had. At this crisis, some one present suggested the idea of opening the valve of the boiler which feeds the engine, and immediately the steam penetrated through the work-shops, the fire was seen to diminish, and soon was reduced to so trifling an extent that it was easily mastered when aid arrived.

This fact cannot have too great publicity ; and it is especially important that manufacturers, captains of vessels, and superintendents of work-shops should be familiar with it.

On Bread.—It is generally admitted that fresh bread differs from that which is stale by containing a larger proportion of water, the change after leaving the furnace being attributed to a gradual drying. It is consequently argued that bread contains the most nutriment in a given weight, when stale.

M. Boussingault has recently shown that the difference between the fresh and stale condition is not due to a diminution of the water, but to a peculiar molecular condition which takes place on cooling, and which continues as long as the temperature remains below a certain limit. M. Thenard explains this transformation by considering the bread a hydrate which heat softens, and a low temperature hardens, or renders less soft. The same effect takes place actually with many substances, as grains, resins, wax, caoutchouc, gutta percha: it is simply a softening by heat, and hardening by cold.

Bread quite stale may be rendered tender after exposure in an oven, heated to 70° C. (158° F.) M. Boussingault has shown that the softening may be produced at a temperature between 50° and 60° C., and that this transformation from soft to stale bread, and the reverse, may take place a number of times. The loss of water is of very small amount. M. Boussingault has observed that bread will become stale even when kept in an atmosphere saturated with moisture.

Chemical Papers read before the Academy of Sciences.—Many communications have been made to the Academy of Sciences since my last communication. Several of them have especially a theoretical bearing and cannot be analyzed in this place. Of this nature is a memoir on *the uric chlorosulphalic and percarbonic compounds*, by M. Laurent, whose impaired health now for two years has weakened his physical vigor, but without diminishing his relish for science, or his passion for research. Another paper is on *an application of the theory of achromatism to the compensation of the angular movements which the rotatory power impresses on the planes of polarization of luminous rays of unequal refrangibility*, by M. Biot, who is always young, and always active, in spite of his 80 years. There are also notes by M. Babinet, and M. Zantedeschi, on the longitudinal lines of the spectrum, etc. etc.

Electrical Machines.—The common electrical machine, so much neglected since it has been dethroned by the pile, still receives from time to time some little improvement. It will be remembered that a means of avoiding the influence of atmospheric humidity, by covering with a thin layer of tallow the glass supports of the conductors, was introduced by M. Munch of Strasburg, a physicist who invented a pile that bears his name, the *pile of Munch.*

Under the hands of M. Provenzali of Rome, the electrical machine is in the way of new progress. This physicist has found that by covering a part of the conductor of an ordinary electrical machine with a thin sheet of gutta percha, the sparks that may be drawn from the part thus covered exceed greatly in length what are afforded by the part uncovered. It appears that this effect depends on the obstacle which the insulating sheet offers to the dispersion of the electricity, which dispersion tends to take place from the asperities of the surface of the conductor, and which discharge in part at a distance this same conductor, whenever it is approached with a non-insulated conductor for drawing the spark. M. Provenzali proposes to cover the whole conductor of the machine in this way, to see if it will not protect it from the action of moist air and give always a considerable quantity of electric fluid.

In order to obtain the largest sparks, it is necessary to have the insulating sheet strongly electrized.

Manufacture of Paper.—It is well known that paper which is very white when first made, often becomes yellow some time after being used. The yellow color is not always uniform, but often comes out in spots more or less large of a circular outline, and a rusty tint. In some Paris manufactories, this defect (which is incorrectly attributed to an alteration of the fibre) is remedied in a simple manner, and as the process of discoloration may not be commonly used in America, judging from some paper I have seen, I make a brief mention of the subject.

The researches were made here by a manufacturer who conbines in a high degree science and technology. M. Gélis recognized at first that the change of color was not due to any alteration in the ligneous fibre, and was owing to iron. But what the source of the iron? and how is it introduced? An examination of the manufacture, through its processes, shows that there is less iron in the pulp than in the paper made from it. The origin of the iron is hence not in the preparation of the pulp, but it must be attributed to the drying cylinders of steel under which it is passed while yet moist. The chlorine contained in the paste, and which it is very difficult wholly to remove by the washish process, becomes suddenly vaporized under the heated cylinders, attacks these cylinders, forms the protochlorid ($FeCl$) which thence impregnates the paper. Colorless itself, this chlorid gradually absorbs oxygen on exposure to the air, and thus the coloration takes place.

It is therefore not a remedy against iron but against chlorine that is required. The hyposulphite of soda is the simple antidote, and a very small quantity suffices to eliminate a large quantity of chlorine, since one equivalent of hyposulphurous acid requires four equivalents of oxygen, and therefore four equivalents of chlorine, to transform it into sulphuric acid.

For testing the complete removal of the chlorine, M. Gélis uses a liquor made of iodid of potassium and amidon (starch). This liquor becomes instantly blue if there is the least trace of chlorine.

On coloring Silk through the Food of the Silk-worms.—The interesting researches of M. Flourens relative to the coloring of the bones of animals through coloring matters taken with their food, are well known. These observations appear to have suggested an application of the principle which promises to make considerable stir in the silk interest. For some years, it has been attempted to color the silk by feeding the worms with organic coloring matters, but till recently the results have been very imperfect, the colors being uncertain and not uniform or bright. The problem has not been altogether solved; nevertheless a long step has been taken through the experiments of M. Roulin who has employed the *chica*, the red coloring matter used by the Indians of Orinoco for coloring their bodies. He sprinkles the leaves of the mulberry with this substance and has thus obtained beautiful cocoons of a rose red color, uniform in tint and apparently permanent.

Sulphate of Quinidine.—There has been recently distributed among commercial men a circular without date or signature and with no indication of its origin, announcing a large adulteration of the sulphate of quinine by a product little known, the *sulphate of quinidine.* It has excited much interest among dealers in quinine, and many methods have been suggested for detecting the presence of quinidine in sulphate of quinine.

This new organic base has been studied successively by MM. Henry and Delondre, Winckler, Howard, Zimmer, and Leers. MM. Henry and Delondre, its discoverers, considered it a hydrate of quinine. MM. Winckler and Leers examined a product made by M. Zimmer of Frankfort, and did not derive their quinidine from the incriminated Quin-

quinas; moreover they give no processes for obtaining the substance. M. Howard has announced that the base is abundantly contained in the *Quinquina cordifolia* of New Grenada, Bolivia, and Peru.

These chemists are not agreed in the composition and properties of the quinidine, and no one of them states the proportions between the quinine and quinidine contained in the suspected barks.

The most striking characteristics of the quinidine appear to be its constant crystallization, its very slight solubility in ether, the greater solubility of its sulphate in water compared with that of the sulphate of quinine.

MM. Bouquet and Schäuffelé have examined a New Grenada Quinquina imported largely into Europe; it comes from near Fusagasuya and is known under the name of *Quinquina caqueta.* Twelve kilogrammes of bark have afforded as pure quinine as that extracted from the *Q. Calysaya;* the sulphate has all the characters of the sulphate of quinine and shows no trace of quinidine.

In the black bittern which affords ordinarily the quinoidine, MM. Bouquet and Schäuffelé have found some grammes of crystallized products, resembling quinidine in some of their characters, but too different to be confounded with it. The total quantity of this crystallized product corresponded to 3 p. c. by weight of the sulphate of quinine obtained, in the treatment of the Quinquina essayed. It is easily understood that the works of a large manufacturer might produce these crystallized matters in small specimens, but not for adulterating the sulphate of quinine.

These authors conclude that the properties of the quinidine are so uncertain that it is prudent to wait for more investigation before admitting it among ascertained chemical bases.

Electric Telegraph.—In the Revue Encyclopedique of M. Moigno, the following line of electric telegraphs is said to be projected:—From London to Paris and Lyons, continued to Chambery and Turin, and to Genoa on the Mediterranean; the Sardinian government will unite Genoa with Spezia; a submarine company will continue it to Bastia across the small island of Gorgona; thence from Bastia to Cagliari in Sicily. A submarine wire uniting Sicily and the African coast can be established without great difficulty. This interval passed, a centre of telegraphic communications will be established at Tunis which the French government will extend to Bougie and Algiers, and the English government to Tripoli, Alexandria, Cairo and Suez.[*]

II. Chemisty and Physics.

1. *On the Epipolic Dispersion of Light.*—Stokes has published the results of an investigation of the very remarkable phenomena accompanying the action of certain substances upon light, first observed by Brewster, and subsequently more carefully examined by Herschel. Herschel observed that a weak solution of sulphate of quinine appears

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[*] On account of the brief time between the receipt of the manuscript of M. Nicklès and the publication of this number we have to defer to our next one part of his paper treating of the standard meter, as it requires large illustrations.

colorless and transparent by transmitted light, but under certain aspects exhibits a blue color. The blue color was produced only throughout a thin stratum of fluid adjacent to the surface by which the light entered. The incident beam, after having passed through the stratum from which the blue light came, was not sensibly enfeebled or colored, but had lost the power of producing a blue color when admitted into a solution of sulphate of quinine. A ray so modified was termed by Herschel, *epipolized*. To explain this remarkable appearance, Stokes assumed that in the process of internal dispersion the refrangibility of light had been changed, and the following experiments place this mode of explanation beyond all doubt. A pure solar spectrum was formed in the usual manner, and a glass vessel containing a weak solution of sulphate of quinine placed in it. The rays belonging to the greater part of the visible spectrum passed freely through the liquid as if it had been water. But from a point about half-way between the fixed lines G and H to far *beyond* the visible extreme violet, the incident rays gave rise to light of a sky blue color which emanated in all directions from the portion of the fluid under the influence of the incident rays. The anterior surface of the blue space coincided of course with the inner surface of the glass in which the fluid was contained; the posterior surface marked the distance to which the incident rays were able to penetrate before they were absorbed. This distance was at first considerable, but decreased rapidly as the refrangibility of the incident rays increased, so that from a little beyond the extreme violet to the end of the blue space the color was reduced to an excessively thin stratum. The fixed lines belonging to the violet and the invisible region beyond, were beautifully represented by dark planes interrupting the blue space. When the eye was properly placed, these planes were projected into lines, and Professor Stokes indentified these with the fixed lines in Becquerel's map of the chemical spectrum. The blue dispersed light corresponding to any particular part of the incident spectrum, is not homogeneous, but consists of rays having a wide range of refrangibility, and not passing beyond the limits of refrangibility of the spectrum visible under ordinary circumstances. Stokes proposes to distinguish the two kinds of internal dispersion as true and false, the latter being merely the scattering of light produced by suspended particles and having nothing to do with the phenomenon of true internal dispersion. True internal dispersion proves to be almost universal in solutions made directly from different parts of vegetables. The tint of the dispersed light and the part of the spectrum at which dispersion begins, are different in different cases. In a decoction of madder in a solution of alum, the dispersion begins above the fixed line D and continues from thence far beyond the extreme violet; the dispersed light is yellow or yellowish orange. In studying these phenomena it is not necessary to use either fluids or clear solids, but washed papers produce, when properly examined, the same effect. Turmeric paper and paper washed with a solution of sulphate of quinine are highly sensitive; the extraordinary prolongation of the spectrum when received on turmeric paper had already been remarked by Herschel. A high degree of sensibility appears to be rare among inorganic compounds, but glass colored by peroxyd of uranium and solutions of the salts of this oxyd are remarkable exceptions.

There is one law relating to the change of refrangibility which appears to be quite universal, namely, that the refrangibility of light is *always lowered* by internal dispersion. The incident light being homogeneous, the dispersed light is found to be more or less composite. Its color depends upon its refrangibility, having no relation to the color of the incident light, or to the circumstance that the incident rays were visible or invisible. The dispersed light appears to emanate in all directions, as if the solid or fluid were self-luminous while under the influence of the incident rays. The effects produced on similar media lead to interesting information with respect to the nature of various flames. Thus the feeble flame of alcohol is extremely brilliant with regard to invisible rays of very high refrangibility. The flame of hydrogen appears to abound in rays of still higher refrangibility, while the light of the electric spark as tested by a weak solution of sulphate of quinine, is found to be very rich in invisible rays of excessively high refrangibility, such as would place them far beyond the limits of the maps hitherto made of the fixed lines in the chemical part of the solar spectrum. These rays are stopped by glass but transmitted through quartz. These circumstances render it probable that the phosphoro-genic rays of an electric spark are nothing more than rays of the same nature as those of light, but which are invisible and of very high refrangibility. If so, they ought to be stopped by a very small quantity of a substance known to absorb these rays with great energy. Accordingly, the author found that the rays from the electric spark which excite phosphorescence pass freely through water and quartz, but are stopped by adding to the water an excessively small quantity of sulphate of quinine.—*L. & E. Phil. Mag., November*, iv, 388.

[NOTE.—Prof. Stokes's discovery of the change in the refrangibility of rays of light, produced by certain media, is undoubtedly one of the finest contributions to this branch of science which has been made since the time of Malus. To the chemist in particular, this discovery opens a new and fertile field of investigation, furnishing a new *characteristic property*, the observation of which must henceforth, like the index of circular polarization, form part of every complete investigation of the properties of a given compound. The abstract of Prof. Stokes's paper in the L. & E. Phil. Mag., from which our own is taken partly verbatim, leaves us however in doubt as to many important particulars. It is not distinctly stated, for instance, whether the rays which are made visible by a solution of sulphate of quinine, are the true chemical rays or not, or whether these rays after the change in their refrangibility, are still capable of producing chemical changes, or whether the light *sifted through* the medium which produces internal dispersion is then capable of affecting a daguerreotype plate. If the true chemical rays can be converted into rays of pure light, then it is not impossible that by a still further diminution of refrangibility, rays of pure light can be converted into rays of heat.—W. G.]

2. *On Heliochromics.*—NIEPCE has communicated to the Academy a third memoir upon this subject, which contains many remarkable facts, and which appears to bring us nearer to the solution of the grand problem of photography—the production of images of objects in their natural colors. After having shown the possibility of reproducing col-

ored engravings upon metallic plates, as had already been accomplished by E. Becquerel, the author proceeded to the employment of the camera obscura, and succeeded in reproducing in their proper colors, pictures, flowers, natural and artificial, and images of dolls dressed in clothes of various colors. All the colors were in these cases, obtained on the metallic plate, while even silver and gold were depicted with their metallic lustre, and glass, alabaster and porcelain, with the lustre peculiar to each. The great difficulty consisted in obtaining all the colors at once, but the author found this possible, and often succeeded in the attempt, by choosing only bright colors of a clear tone, and the more brilliant of the dark colors. The most difficult color to obtain with the others, is the green of foliage, the green rays being almost as inert as the black ones; clear green colors, particularly if brilliant, as in glazed green paper, were, however, reproduced in a satisfactory manner. In all cases, the colors produced were transitory, and no method of permanently fixing them has yet been devised, but M. Niepce does not despair of accomplishing this, and has already obtained some results which appear to point out the path which is to lead to ultimate success.—*Comptes Rendus*, xxxv, 694.

3. *Fluorid of Antimony.*—FLÜCKIGER has studied the relations of antimony to fluorine and has found that but a single compound of these elements, namely, the terfluorid, exists. When an aqueous solution of fluohydric acid is poured upon oxyd of antimony, a solution immediately takes place accompanied by the evolution of great heat. By evaporating the acid solution slowly at 70° to 90° C., colorless transparent crystals are obtained which belong to the right rhombic system, and are combinations of an octahedron with a predominating rhombic prism. The crystals cannot be dried, but deliquesce even between folds of bibulous paper. They leave a sharply acid afterward styptic taste, and dissolve in water without decomposition. On evaporating the solution, however, the salt is decomposed and an insoluble oxyfluorid precipitated. The formula of the fluorid was found to be SbF_3, and all attempts to prepare the compounds SbF_4 and SbF_5 were unsuccessful. By mixing oxyd of antimony and carbonate of potash together in atomic proportions and adding an excess of fluohydric acid, Flückiger obtained two crystalline salts represented by the formulas $SbF_3 . KF$ and $SbF_3 . 2KF$. With the fluorids of sodium, lithium and ammonium, the fluorid of antimony forms salts represented by the formulas $SbF_3 . 3NaF$, $SbF_3 . 2LF$, $SbF_3 . 2NH_4F$. From these results it is evident that the fluorid of antimony is tribasic, bibasic, and monobasic, like phosphoric acid, so that we may represent its combinations by the general formula $SbF_3 . (1.2.3) RF$. Flückiger adopts the views of Bonsdorff, Boullay, Thomson and Hare, in regard to the constitution of the so-called fluorids, and considers them as perfectly analogous to the oxygen salts of corresponding constitution. [This view, long and earnestly maintained in this country by Dr. Hare, is gradually gaining ground at the present day, though but a few years since ridiculed or ignored by writers on systematic chemistry.]—*Pogg. Ann.*, lxxxvii, 245.

4. *Anhydrous Valerianic Acid.*—CHIOZZA has obtained anhydrous valerianic acid by the method which Gerhardt has applied to the isola-

tion of acetic and butyric acids. When oxychlorid of phosphorus, PCl_3O_2, is brought into contact with valerianate of potash, a violent reaction takes place and the odor of the oxychlorid disappears. By treating the mass with a weak solution of carbonate of potash, and then with ether, and evaporating the etherial solution, the anhydrous acid is obtained as a limpid, highly mobile liquid, lighter than water, and possessing a feeble odor of apples. The liquid boils at 215°, and distills over perfectly colorless: its vapor irritates the eyes and provokes coughing. The reaction by which the anhydrous valerianic acid is obtained, is represented by the equations,

$$PCl_3O_2+3(C_{10}H_9O_3, KO)=PO_5\ 3KO+3(C_{10}H_9O_2Cl)$$

$$3(C_{10}H_9O_3, KO)+3(C_{10}H_9O_2Cl)=3KCl+3(C_{10}H_9O_3)$$

the oxychlorid of valeryl, $C_{10}H_9O_2Cl$, is here first set free and then reacts on another portion of the valerianate of potash.

By the action of oxychlorid of benzoyl on valerianate of potash the author has also obtained a compound of anhydrous valerianic with anhydrous benzoic acid represented by $C_{10}H_9O_3+C_{14}H_5O_3$. It is an oily liquid, heavier than water, and leaving an odor like that of anhydrous valerianic acid. By distillation it is separated into anhydrous benzoic and anhydrous valerianic acids. Alkaline solutions transform it into valerianates and benzoates.

By the action of aniline upon anhydrous valerianic acid Chiozza has prepared valeranilide crystallizing in magnificent rectangular tables fusing at 115° C. Its formula is $NC_{12}H_6, C_{10}H_9O_2$.—*Comptes Rendus*, xxxv, 568.

5. *New compound of Cobalt.*—SAINT EVRE has described a remarkable compound which is obtained when a cold and concentrated solution of nitrite of potash is brought into contact with a cold and concentrated solution of nitrate of cobalt; nitric oxyd is evolved while an insoluble yellow precipitate is thrown down. The supernatant liquid contains a considerable quantity of nitrate of potash. A simple method of preparing it is to precipitate nitrate of cobalt by potash and then to pass a current of nitric oxyd through the resulting rose colored magma. The compound thus formed is of a brilliant yellow color and crystalline structure: it is insoluble in water but is decomposed by boiling water with evolution of nitric oxyd; in contact with air in this case nitric acid is formed and the liquid contains nitrate of cobalt and nitrite of potash. When suspended in water it resists for a long time the action of chlorine and is only decomposed by heating; sulphydric acid has also no effect upon it, but sulphid of ammonium produces a black sulphid of cobalt. Acids decompose the new compound with formation of red vapors; a solution of caustic potash precipitates the hydrated sesquioxyd of cobalt. Heated in the air the substance becomes at first orange yellow, then fuses, disengaging water, red vapors of hyponitric, and white vapors of nitric acid. [Saint Evre gives the formula $2(CO, KO, N_2O_3)+HO$, as representing the constitution of this remarkable compound, but his analysis was conducted by a singularly complex process which could hardly give accurate results, and the reaction with caustic potash shows conclusively that the cobalt is present as sesquioxyd and not as protoxyd.]—*Comptes Rendus*, xxxv, 552.

W. G.

6. *Separation of Manganese from Iron and Nickel;* by Dr. T. Schiel,* St. Louis, Mo.—If a current of chlorine is passed through a diluted solution of acetate of manganese, or better, through a mixture of chlorid of manganese and acetate of soda, the acetate of manganese is decomposed after a very short time and all the manganese precipitated as peroxyd, while the acetates of iron and of nickel are not affected under similar circumstances. Therefore, if a solution of chlorids of manganese nickel and iron contains free hydrochloric acid, a sufficient quantity of acetate of soda is added to convert all the chlorids into acetates and bind the free hydrochloric acid. The free acetic acid thus liberated, does not prevent the formation of peroxyd of manganese. By this method, cobalt cannot be separated from manganese, because it is also *partly* precipitated.

7. *Phosphoric Acid in some of its relations to Physiology and Pathology;* by D. Breed, M.D., of New York.—Early in 1850, Professor Liebig directed my attention to the chemical constitution of the nervous system, as an important and unexplorable field. My first object was to determine the constituents of the incombustible matter of the brain, by burning that organ, and then analyzing the ash. Nearly 50 per cent. of the ash of an ox's brain proved to be phosphoric acid, and as more than 40 per cent. of phosphoric acid was obtained from the ash of the brain of a hospital patient, there is little doubt that healthy human brain would yield at least 50 per cent.

Finding this extraordinary quantity of phosphoric acid in nervous matter, and believing that it must play an important though almost unknown part in the human economy, I immediately commenced a research upon the subject of phosphoric acid in urine. After making several hundred determinations† of that acid in normal human urine, I am led to the following conclusions:—

1st. A person weighing 150 lbs., in health, of regular habits, discharges unifomly about 4,000 grammes (average of 24 days) of phosphoric acid in 24 hours.

2d. The quantity is greater during the day than during the night, both per cent. and per hour.

3d. The amount of water drank in 24 hours does not materially alter the quantity of phosphoric acid discharged.

4th. Taking an excess of common salt diminishes the amount of phosphoric acid, while taking potash increases it.

From the accompanying statistics derived from experiments which I made in the hospitals of Giessen and Zürich, it will appear that diseases generally very much reduce the amount of phosphoric acid. The case of phthisis, although not having yet reached the suppurative stage, and the patient not much emaciated, gave an extremely small portion of acid, compared with the normal standard: the amount of acid was increased in the cases of epilepsy and apoplexy, and not much diminished in the case of mollities ossium.

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* By an oversight in the chemical dictionary of Booth and Morfit, article "Madder," Schiel's name is written "Shiel;" in the article "Sanguinarin," it is even written "Scheele."

† See "Annalen der Chemie und Pharmacie," 1851; also the Report of the American Association for the Advancement of Science, 1851.

As it has lately been shown that nine or more species of phosphoric acid exist, it becomes interesting to inquire, what modification that substance assumes in urine; and, as tending to the solution of the problem, the following results are important.

By neutralizing a known quantity of phosphate of potassa in solution, with a solution of perchlorid of iron (according to the well-known method of Guy-Lussac for alkalimetry), in presence of acetate of soda, and then determining the amount of iron required to neutralize the phosphoric acid, I found that one atom of peroxyd of iron (Fe_2O_3), corresponds to one atom of phosphoric acid (PO_5). We doubtless have the same atomic proportions (Fe_2O_3, PO_5), in the phosphate of iron produced by treating urine with perchlorid of iron; therefore, as water is present in both these cases, we probably have in urine tribasic phosphoric acid, corresponding to the following formula: $Fe_2O_3 + 2HO, PO_5$.

		Cubic centimetres.		Grammes.
Case 1st, Rheumatism in the joints.—	Urine of 24 hours,	1322	Phos. acid,	2·260
	" "	1050	" "	2·793
	" "	1290	" "	3·127
2d, Carcinoma of the liver:	" "	580	" "	2·204
	" "	750	" "	2·191
	" "	700	" "	1·862
	" "	765	" "	2·107
	" "	1187	" "	2·812
3d, Phthisis:	" "	1296	" "	1·630
	" "	1142	" "	1·411
	" "	1219	" "	1·790
4th, Intermittent Fever:	" "	920	" "	1·120
	" "	763	" "	2·421
	" "	947	" "	2·782
	" "	1303	" "	2·970
5th, Apoplexy:	" "	1188	" "	5·428
	" "	1385	" "	5·540
	" "	1415	* " "	5·660
	" "	1415		5·660
6th, Epilepsy:	" "	2294	" "	8·260
	" "	1275	" "	5·679
	" "	1820	* " "	5·005
	" "	1820		5·005
	" "	1217	* " "	3·407
	" "	1217		3·407
	" "	1165	* " "	3·391
	" "	1165		3·391
7th, Mollities Ossium:	" "	587	* " "	4·465
	" "	587		4·465
	" "	544	* " "	3·268
	" "	544		3·268
	" "	633	* " "	3·070
	" "	633		3·070

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* One half of the amount for 48 hours.

III. MINERALOGY AND GEOLOGY.

1. *On Petalite and Spodumene;* by C. RAMMELSBERG, (Ann. der Physik und Chemie, lxxxv, 544, 1852.)—The discrepancies in the analyses of these minerals have led M. Rammelsberg to new researches with regard to their composition, and we here give an abstract of his paper on the subject.

The analyses were made by means of carbonate of soda and hydrofluoric acid, and with special precautions for accuracy. The following are the results. Specific gravity of the Utö mineral, 3·1327; of that of Tyrol, 3·137.

	Utö.			Tyrol.		
	With carb. soda.	With hydrofl. acid.		With carb. soda.		With hydrofl. acid.
Silica,	65·02			*undet.*	65·53	
Alumina,	27·70	29·47	30·26	27·91	29·97	29·25
Protox. iron,	*trace*	*trace*	*trace*	*undet.*	1·40	1·45
Lime,	0·80	0·20	*undet.*	0·84	0·87	1·07
Magnesia,	0·15	*trace*		0·09	0·06	0·06
Lithia,		5·50	5·35			4·49
Soda,		0·56	0·51			0·07
Potash,			0·14			0·07

Mean of the results

	$\overline{\overline{\mathrm{Si}}}$	$\overset{\cdots}{\mathrm{\rlap{-}Al}}$	$\hat{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Li}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$
1. Utö,	65·02	29·14	*trace*	0·50	0·15	5·47	0·46	0·14=100·88
Oxygen,	33·78	13·61		0·14	0·06	3·00	0·11	0·02
2. Tyrol,	65·53	29·04	1·42	0·97	0·07	4·49	0·07	0·07=101·61
Oxygen,	34·05	13·56	0·31	0·26	0·03	2·46	0·02	0·01

The first gives the oxygen ratio, 3·33 : 13·61 : 33·78=1 : 4·0 : 10·1.
The second " " " 3·09 : 13·56 : 34·05=1 : 4·4 : 11·0.
Taking 1 : 4 : 10 as the most probable ratio, the formula becomes

$$\dot{\mathrm{R}}^3\,\overline{\overline{\mathrm{Si}}}^2+4\overset{\cdots}{\mathrm{\rlap{-}Al}}\,\overline{\overline{\mathrm{Si}}}^2,$$

making spodumene a compound of two *bisilicates.**

The analysis of Hagen of the Utö mineral, gave as a mean, 65·022 of silica to 26·837 of alumina, with 3·836 of lithia, affording the oxygen ratio 3·00 : 12·53 : 33·79=1 : 4·18 : 11·26, which Hagen makes 1 : 4½ : 12. Berzelius found the ratio 1 : 4 : 12. For the Sterling (Mass.) spodumene Hagen obtained silica 65·247, and alumina 27·556.

M. Rammelsberg next cites the analyses of Mr. G. J. Brush from this Journal (vol. x, p. 370), and alludes to its agreeing with Stromeyer's analysis of the Utö mineral in the silica, in which this last mentioned chemist differs from Arfvedson, Regnault and Hagen who found 65 to 66 per cent. Specific gravity of the Norwich spodumene according to Mr. Brush, 3·18.

In an earlier analysis of the spodumene of Conway, Bowen found 65·3 p. c. of silica and 24·5 of alumina.

From all the analyses, Rammelsberg infers that the formula he has deduced is the true formula.

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* Kobell early deduced a similar formula, before soda was known to exist in the mineral.

The measurements of the crystals given by Hartwall and Dana, with the figure by the latter,* are next cited, and a comparison made with the form of crystals of augite, the near identity with which was first mentioned by the latter. These measurements were approximations only, made by means of the common goniometer, and some of the faces were quite uneven. The following comparison is made.

Augite.		Spodumene.	
M : *M* =	87° 06′	N : N =	87°
M : *r*	133 33	N : M	113 to 133° 30′
M : *l*	136 27	N : l	137 to 136 30
r : *l*	90 00	M : l	90
r : *t*	74 01	P : M	69 40
s : *s*	120 38	a : a	117
o : *r*	103 20	a : M	100 30
z : *z*	80 28	$t^2 : t^2$	79 30
z : *l*	139 56	t^2 : l	139 45 to 140°
o : *o*	95 36	$a^2 : a^2$	
o : *r*	118 24	a^2 : M	116

The plane b^3 has not been observed in augite. Its inclination to M was ascertained to be 107°. It must therefore be the plane $a : \frac{1}{3}b : \infty c$, which in augite would have for its inclination on M, 106° 57′. The other planes will have for the axes *a*, *b*, *c*, (*a* and *b* being the lateral and *c* the vertical) :—N (*M* Augite) $= a : b : \infty c$; $M(r) = a : \infty b : \infty c$; $b\,(l)$ $\infty a : b : \infty c$; $\mathrm{P}\,(t) = \infty a : \infty b : c$; $a\,(s) = a' : b : c$; $t^2\,(z) = \infty a : b : 2c$; $a^2\,(o) = a' : b : 2c$; $b^3 = a : \frac{1}{3}b : \infty c$.

The isomorphism of spodumene and augite is an example of a similarity of form with unlike constitution. Still there is some analogy between them. Calculating the atomic volume, we have for spodumene (supposing the soda to the lithia as 1 to 27, and the specific gravity 3·13) 2840. Dana has found that the atomic volume of isomorphous bodies are very nearly equal when the atomic volume is divided by the number of atoms of elements in the compound. The atomic weight of diopside (lime-magnesia augite) is 2043·74, the specific gravity 3·28; hence the atomic volume =623. The number of atoms of elements in $\dot{\mathrm{C}}\mathrm{a}^3\,\overline{\overline{\mathrm{Si}}}{}^2 + \dot{\mathrm{M}}\mathrm{g}^3\,\overline{\overline{\mathrm{Si}}}{}^2$ is 28, and therefore $623 \div 28 = 22$.† In spodumene the number of atoms is 66; or if alumina contains 1 of aluminium instead of 2, it is 62; dividing 2840, by these numbers we have 43 or 45½.

Petalite.—The analysis of petalite afforded Rammelsberg as the mean of his results,

	$\overline{\overline{\mathrm{Si}}}$	$\bar{\mathrm{A}}\mathrm{l}$	$\dot{\mathrm{L}}\mathrm{i}$	$\dot{\mathrm{N}}\mathrm{a}$
	77·79	18·58	3·30	1·19
Oxygen,	40·42	8·67	1·81	0·30

Affording the ratio 2·11 : 8·67 : 40·42=0·95 : 3·86 : 18=1 : 4·1 : 19·1. 1 : 4 : 18 gives $3\dot{\mathrm{R}}\,\overline{\overline{\mathrm{Si}}}{}^2 + 4\bar{\mathrm{A}}\mathrm{l}\,\overline{\overline{\mathrm{Si}}}{}^3$; and 1 : 4 : 20 gives $\dot{\mathrm{R}}^3\,\overline{\overline{\mathrm{Si}}}{}^4 + 4\bar{\mathrm{A}}\mathrm{l}\,\overline{\overline{\mathrm{Si}}}{}^4$. The former affords the percentage, Silica 76·43, alumina 18·90, lithia 3·44, soda 1·23=100; the latter, Silica 78·27, alumina 17·42, lithia 3·17,

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* This Jour. [2], x, 119, 264, and Dana's Mineralogy, 3d edit. p. 693.

† Taking the general formula $\dot{\mathrm{R}}^3\,\overline{\overline{\mathrm{Si}}}{}^2$ for the augite (in the same way as the general formula is used for the spodumene) and it gives for the number of atoms 14, and the atomic volume 44. In the next sentence above we have made a slight correction.—J. D. D.

soda 1·14=100. *Castor*, according to Plattner, afforded silica 78·01, alumina 18·85, lithia 2·76, agreeing nearly with petalite in its alumina and silica. Still according to Plattner it contains no soda, and it afforded the ratio 1 : 6 : 27. We have not therefore as yet sufficient grounds for pronouncing them identical.

2. *On Humite*; by M. RAMMELSBERG, (Ibid. vol. lxxxvi, p. 413.)—Rammelsberg gives the following as the results of his analyses of the three varieties or types of Humite, (see this Journal, vol. xiv, p. 175.)

	$\overset{\cdots}{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Fe}}$	$\overline{\overline{\text{Al}}}$	Fe
I.	34·80	60·08	——	2·40	——	3·47 = 100·75
II.	33·26	57·92	0·74	2·30	1·06	5·04 = 100·32
III.	36·67	56·83	——	1·67	——	2·61 = 97·78

These give the general formula $(4\text{Mg Fl}+\text{Si Fl}^3)+n\,\dot{\text{Mg}}^4\overset{\cdots}{\text{Si}}$, in *which n* equals, for Chondrodite, 12; for Humite of the type II, 18; for I, 27; for III, 36. Rammelsberg shows farther the equality of atomic volume between Olivine and Humite, according with the similarity of crystallization pointed out by Scacchi.

3. *Fossil Bones, probably Reptilian, from the Coal formation of Nova Scotia, discovered by Mr. Dawson and Sir Charles Lyell*, (Boston Evening Traveller, Nov. 10, 1852.)—In our report of the Lowell Lecture of last night, allusion is made to the first example of the bones of a fossil reptile of the carboniferous epoch, discovered on the American continent. They were found by Mr. Dawson, of Pictou, and Sir Charles Lyell, in September last, in the interior of an erect fossil tree, on the shore of the Bay of Fundy at the South Joggins near Amherst.

The largest of the fossil species appears to have been between two and three feet long. Another, of which the vertebral column is preserved, was much smaller, probably not more than 6 inches in length.

In the same group of fossils are observed fragments of jaw-bones with conical teeth, and sculptured dermal plates, probably parts of the same batrachian quadrupeds. There was also found associated with them the shell of a Mollusk, apparently a pulmoniferous gasteropod, (Cyclostoma or Pupa?) a family of land shells, of which no representatives had previously been met with in rocks of so high antiquity.

IV. BOTANY AND ZOOLOGY.

1. *Mohl, Grundzüge der Anatomie und Physiologie der vegetabilischen Zelle.* Braunschweig, 1851; pp. 152, 8vo.—This is a separate issue of an article by Prof. Mohl in Wagner's *Handwörterbuch der Physiologie.* It is a condensed systematic treatise on Vegetable Anatomy and Physiology; and, as it is the only work in which Prof. Mohl has treated the subject in a general manner, it is one of great importance; the author being the very highest authority in vegetable anatomy and phytogeny. We are happy to announce that an English translation has been prepared by Mr. Henfrey, which will shortly be published by Van Voorst. When it appears we hope to present our readers with an abstract of the work. A. G.

2. *Hermann Schacht, Die Pflanzenzelle, der innere Bau, und das Leben der Gewächse.* Berlin, 1852; pp. 472, tab. 20, roy. 8vo.—This is the latest and fullest general treatise on the whole subject of vegetable anatomy and physiology; and by an author who has exhibited

much talent for this kind of research. It is illustrated by 390 good original figures, on stone, in 20 plates. As to the formation of the embryo he holds the Schleidenian view.—In connexion with the above, we may enumerate two treatises by Hofmeister of Leipsic, namely, *Die Entstehung des Embryo der Phanerogamen*, 1849, pp. 89, tab. 14, 4to, and *Vergleichende Untersuchungen der Keimung, Entfaltung und Fruchtbildung höherer Kryptogamen, und der Samenbildung der Coniferen*, 1851, pp. 179, tab. 33;—two works of which we should be glad to give an extended analysis. A. G.

3. *Lindley, Folia Orchidacea; an Enumeration of the known species of Orchids.* Part I. Oct., 1852. 8vo. London. Published for the Author, by J. Matthews.—A revision and complete enumeration of the Orchideæ now known has long been greatly wanted; and no one is competent and prepared for the undertaking except Dr. Lindley. His *Genera and Species of Orchidaceous Plants* was commenced in 1830, and terminated in 1840; since which time the number of known species has multiplied enormously. It is stated that there are now in cultivation in Great Britain a greater number of species than were known in 1830 from books and herbaria taken together. The plan of the present revision of the family is different from that of the former work. The genera do not follow in regular sequence, according to any established plan of arrangement. But those of which the author possesses the most complete information are taken first; while those of which he has imperfect materials are postponed, in hope that the requisite data may be supplied while the publication is in progress. To elicit the information needed, a list of genera imperfectly or wholly unknown to Dr. Lindley is given on the cover;—in which we are surprised to find one of our North American Genera, namely, the *Tipularia* of Nuttall. We call the attention of our correspondents and botanical friends, who possess duplicates or can obtain specimens of this rare plant, in order that the want may be supplied. Specimens sent to the writer of this notice will be duly forwarded to Dr. Lindley. The first part of the Folia Orchidacea contains *Stanhopea*, *Odontoglossum*, and five smaller genera. Each genus is paged separately so that the whole may be arranged systematically or alphabetically, when the work is completed; and the date of publication is printed at the bottom of the first page of each genus.

The second part, containing *Epimedium*, was probably issued at Christmas. A. G.

4. *Remarks on the Mode of Vegetation of European and North American Trees transported to Madeira*; by Prof. OSWALD HEER, (Ann. Mag. Nat. Hist., [2], x, 396, from Bib. Univ. de Geneva, Aug., 1852, p. 325.)—M. Heer, of Zurich, so well known by his observations on the botanical geography of the Swiss mountains, having been compelled by the state of his health to make some stay at Madeira, has employed his time while there, in studying, in various points of view, the vegetation of that island, the climate of which is remarkably equable throughout the year.

Since his return he has laid before the Société Helvétique des Sciences Naturelles, several interesting observations relative to the periodical phenomena of vegetation. After remarking that all the woody plants of Madeira are evergreen trees or shrubs, blossoming very often during the cool season, he observes how much the species introduced from more northern countries contrast with these indigenous species in their mode of vegetation.

The oak and the beech, for instance, continue to lose their leaves during the winter, although the weather is then milder than it is in several parts of Europe during the summer. Thus, at Funchal, the leaves of oaks (*Quercus pedunculata*) planted in some public gardens and promenades, began to grow yellow at the end of October, and gradually became dried up to the 1st of January. Some isolated trees began to shoot by the 10th of January, and were green again on the 6th of February; but all the others remained in a state of repose and were not generally covered with new leaves until the 20th of February. In Mr. Gordon's garden, at an elevation of 1800 feet, they were a month later.

The leaves of the beech became yellow at Funchal by the 8th of November, at Mr. Gordon's garden by the 28th of October. The leaves, or at least the greater part of them, remained in a dry state upon the trees, until they began to shoot in the spring, which was about the 1st of April. At Funchal, the terminal buds were open by the 8th of April, and the lateral a little later.

At Glaris, the period of repose of the beech on an average is 194 days; in Madeira, where the cold season is like the summer at Glaris, it is 149 days. The difference is only 45 days. The oak in Switzerland has a period of repose nearly equal to that of the beech, whilst at Madeira it is only 110 days, or 49 days less than the beech. M. Heer supposes that this difference may arise from the beeches of Madeira having been introduced from England and the oaks from Portugal, so that the latter would have previously acquired the habit of losing their leaves later and vegetating sooner than in the center of Europe.

M. Heer ought perhaps to have added, what he no doubt knows, that sudden variations of temperature in the twenty-four hours, especially the instantaneous diminution to 32° Fahr. or lower, are one of the great causes of the fall of the leaves in Switzerland. The absence of these variations retards the phenomenon in the west of Europe, and still more in Madeira.

In the facts stated by M. Heer,—facts of which we previously had examples in the hothouse culture of tropical plants,—there is a proof of that important physiological law, too often forgotten by meteorologists, that *the same temperature or the same sum of temperatures, combined with the season, does not always produce the same effect upon organized beings.*

Every species is as it were a machine which performs its functions under the influences of external causes, modified by particular internal conditions. These vary not only between one species and another, between one race of a species and another, and even up to a certain point between one individual and another, but also between one period and another,—the same heat after the repose of vegetation for instance, not producing the same effect as in other circumstances.

In Madeira, the *Platanus occidentalis*, a native of the United States, loses its leaves very slowly from the middle of October, or rather they gradually become yellow and fall afterwards from the action of wind and rain. The repose is complete in January, February, and up to April, during a period of 87 days. The *Liriodendron tulipifera*, also a native of North America, has a complete repose of 151 days.

The apple and pear trees generally begin to lose their leaves in December. They come into flower, at Funchal, by the 7th of April, and their fruit is collected in August. There are, however, varieties of apple and pear trees which flower and produce fruit twice in the year, and one variety of apple is perpetually in flower and fruit. The peach trees about the 4th of November already exhibit some flowers amongst their leaves; they then, to the great astonishment of M. Heer, continued blossoming in abundance during the months of December and January, and the fruit came to maturity from the 23d of February to the end of the summer. In February there were flowers on the upper parts of the trees and fruit below, and it was also then the leaves were renewed, the interval between the falling and shooting of the leaves being scarcely sensible. The vines around Funchal began to lose their leaves about the 24th of October. The soil of the vineyards in winter offered the singular appearance of being covered with the flowers of *Oxalis speciosa* (a Cape plant) and of *Calendula arvensis.* New leaves appeared by the end of March, and by the 8th of April the vines were completely in leaf, with young floral grapes. The flowers open at the end of April and the beginning of May, and the vintage takes place in September. The repose lasts 157 days.

5. *On Fossil Pachydermata in Canada;* by T. COTTLE, (from a letter to the Editors of the Annals of Natural History, [2], x, 395, dated Woodstock, Upper Canada, April, 1852.)—I think it may be worth while to record the first discovery of the remains of one of the large extinct Pachydermata in Canada; for the Mastodon's remains mentioned by Lyell are found on the right bank of the Niagara, which is not in the province, although so close as to be only divided from it by that river.

At the latter end of January, in cutting through, for the transit of a railway, a narrow spit of land at the head of Lake Ontario known as Burlington Heights, two bones of an Elephant were discovered (*E. primigenius ?*), viz. the whole of the right ramus of the lower jaw to beyond the symphysis, and a tusk. The tusk was much curved, as will appear from the following dimensions:—length along the greatest curve, 6 ft. 8 in.; from the base straight to the point, 4 ft. 2½ in.; two feet from the base, to which length I suppose was imbedded in bone, straight to the point, 3 ft. 3¾ in. The dimensions of the jaw are—from the angle to the symphysis 19 in., from the condyloid process to the symphysis 2 ft. 2 in., from the angle to the top of the condyloid process 18 in., from base of angle to top of the coracoid process 12 in. The jaw contained only one molar; this tooth was very perfect; the width of the upper surface 3¼ in., the length 13, of which 4¾ had been used.

The remains were found 40 feet below the surface and 60 above the level of the lake, in a layer of sand, superimposed on which were successive layers of cemented gravel and sand, the layers of gravel varying both in width and in the size of the pebbles: this narrow spit of land seems to have been a bar formed at the mouth of a large estuary which must have flowed into Lake Ontario. To the east of this bar is Burlington Bay, the head of Lake Ontario, from which it is separated by a similar bar through which a canal is cut into the lake, and which bank I am informed is still rising. To the west are the Dundas marshes, which find their exit into Burlington Bay round the point of Burlington Heights, and through which the Desjardin Canal is carried. Behind Dundas, running east and west, is a long, deep and wide valley bounded on the north and south by ridges of Niagara limestone, and down which valley doubtless once flowed a large body of water.

In sinking a coffer-dam near this spot for the foundation of a bridge where the railroad will cross the Desjardin Canal, were found, deep in the silt, the scapular and some fragments of the bones of the extremities of an herbivorous animal about the size of a fallow-deer.

V. ASTRONOMY.

1. *The Nineteenth Asteroid.*—The planet discovered on the 22d of August, 1852, by Mr. J. R. Hind of London, has been named *Fortuna.*

2. *The Twentieth Asteroid,* (Comptes Rendus, xxxv, 674.)—Prof. A. de Gasparis has adopted for the planet discovered by him on the 19th of September, 1852, the name *Massalia*, out of respect to M. Chacornac of Marseilles, who discovered the planet independently on the 20th. The following elements of this planet, computed by Mr. George Rümker from the Hamburg observations of September 30, October 26, and November 19, have been communicated to the *Astronomical Journal.*

Epoch 1852, November 0, m. t. Berlin.

Mean longitude, . .	297° 0′ 46″·0	
Longitude of perihelion, .	94 32 39 ·7	Mean Equinox 1853, Jan. 0.
" " asc. node, . .	207 8 47 ·6	
Inclination, ...	0 40 28 ·1	
Angle of excentricity, .	10 3 27 ·5	
Log. of semi-axis major, .	0·3890493	
" mean daily motion, .	2·9664326	

3. *New Planets—Twenty-first Asteroid,* (Astr. Jour., No. 52.)—At Paris on the 15th of November, 1852, another planet, which has been named *Lutetia*, was discovered by Mr. H. Goldschmidt. It resembled a star of the 9·10 magnitude. Mr. G. Rümker has computed the following elements, from observations made at Paris, November 18, and Hamburg, November 28 and December 3.

Epoch 1852, December 0·0, Berlin m. t.

Mean longitude, . .	61° 29′ 23″·3	
Long. of perihelion, .	309 53 19 ·4	Mean Equinox 1853·0.
" " asc. node, .	78 38 48 ·4	
Inclination, . .	3 19 49 ·7	
Angle of excentricity, .	19 51 55 ·2	
Log. of semi-axis major,	0·4157699	
" mean daily motion,	2·9263517	

4. *Twenty-second Asteroid,* (Astr. Jour., No. 52.)—On the 16th of November, 1852, Mr. J. R. Hind discovered a new planet which he

estimates as of the 10·9th magnitude. By comparison with LALANDE 10056, he obtained Nov. 17, $11^h\ 51^m\ 52^s$ Gr. m. t., R. A. $5^h\ 12^m\ 49^s{\cdot}38$, and N. P. D. 65° 26′ 44″·5. Mr. E. Vogel has calculated the following elements from observations of November 19, 24 and 30.

Epoch 1852, December 0·0, Greenwich m. t.

Mean longitude, ...	22° 27′ 0″·5	
Long. of perihelion, . .	46 13 28 ·9	Mean Eqx. 1852·0.
" " asc. node, . .	66 53 6 ·1	
Inclination, ...	14 20 12 ·6	
Angle of excentricity, . .	6 0 11 ·8	
Log. of semi-axis major, . .	0·4685289	
Mean daily motion, . . .	703″·41748	

Mr. Adams, being requested to name this planet, has proposed to call it *Calliope*.

5. *Twenty-third Asteroid*, (Astr. Jour.)—In a letter to the editor of the *Astronomical Journal*, Mr. J. R. Hind announces the discovery of another planet at $6^h\ 30^m$ of Dec. 15, 1852. He describes it as shining like a star of the 10·11th magnitude, with a pale bluish light. By comparison with LALANDE 6129, he found the following positions:

1852.	Greenwich m. t.	R. A.	N. P. D.
Dec. 15.	$7^h\ 18^m\ 39^s{\cdot}2$	$3^h\ 12^m\ 4^s{\cdot}98$	73° 10′ 16″·4
	8 42 2 ·0	3 12 2 ·70	73 10′ 3″·9
Daily motion about . .		-39^s	−3′·5

Mr. Bishop, at the request of Mr. Hind, has selected for this planet the name *Thalia*.

VI. MISCELLANEOUS INTELLIGENCE.

1. *Ericsson's Caloric Engine.*—The moving power in Ericsson's Engine is well known to be the expansion of air by heat, which expansion at 32° F. is about $\frac{1}{490}$ for each degree of Fahrenheit added. It is now a fact that this power has been proved sufficient to move a vessel of the largest size at the rate of 7 miles an hour; and the public wait with much interest for the final trials that shall test its claim to be admitted as a successful rival of steam. For a large and accurate drawing of Ericsson's Caloric Engine, we refer our readers to a plate in the February number of Appleton's Mechanics' Magazine, which was furnished by Capt. Ericsson himself. The following particulars are mainly from this plate, and from Capt. Ericsson's description accompanying it. It represents the stationary test-engine, which is better for illustration than that in the ship.

In this stationary engine, two working cylinders 5 feet in height, with pistons 6 feet in diameter, stand about 1 foot apart. Each of these cylinders is concave at bottom, and rests directly over the fire. Upon the top of each working cylinder is built a second smaller cylinder (called the *supply cylinder*) wholly separate in its chamber from that below; it is nearly 5 feet in diameter, and $4\frac{1}{2}$ in height. This upper cylinder appended to each working cylinder for supplying the air, has also its piston; and both pistons, having their centers in the same line, work up and down together with the same shaft; the two pistons being connected by two rods. The working piston, or that of the lower cylinder, is two feet or so thick, the interior being filled with clay and charcoal to prevent the conduction of heat through from below.

On one side of either large cylinder near the bottom, there is an opening for the entrance of the air for raising the piston and for its passage out as the piston descends; and close by this opening, just outside, there is a mesh-work of wire, called the *regenerator*, through which the air passes, both on entering and going out. This regenerator is 26 inches high and wide, and is filled with 200 disks of wire-net, having 10 meshes to the inch, making 67,600 meshes in each disk, and 13,520,000 in the whole regenerator, forming thus an apparatus for cooling the air that leaves the engine, and at the same time for warming the air that enters. There are 41½ miles of wire in each regenerator, and the amount of surface it presents is 2014 square feet, equal to the entire surface of 4 steam boilers, 40 feet long, and 4 feet in diameter. The air going out loses about 480° F. of its temperature, and the same amount is the next moment communicated to the air passing in.

The supply-cylinder, (upon each working cylinder,) is simply a pump for pumping in air. As its piston descends (simultaneously with the working piston), a valve at top opens from external pressure, and air passes in from without. On rising, the pressure closes this valve, and opens another; and through the latter the air passes into a flue, opening into the *air-receiver*—a large rectangular box placed vertically, measuring 7 feet by 3½. From the bottom of this air-receiver, a flue leads to the regenerator, and so into the large cylinder below the working piston. Thus there is a free communication for the air from the upper cylinder (the supply-cylinder) through the air-receiver alongside into the bottom of the lower or working cylinder, the air passing through the *regenerator* just before entering the latter. The ascent of the upper piston expels the air from the upper cylinder, and compels this air to make this circuit. Just before reaching the regenerator, there is a valve, which closes through the action of the engine, when the air has raised the piston ¾ths of the full up-stroke; but until this moment on the rise of the pistons, the communication is free between the upper part of the upper cylinder and lower part of the lower cylinder. When the working piston has reached its full height, the air which has raised it is to be got rid of: for this purpose, another valve opens, and this air (first making its way, as above said, through the regenerator, where it is deprived of its heat), passes out through this valve, and escapes into the atmosphere; when the piston begins to fall by its weight.

The commencing *descent* of the piston again opens the valve at the top of the supply cylinder, letting in the air from the atmosphere around; and next, its *rise* closes this valve and opens that one leading through the air-receiver and regenerator to the lower cylinder below the piston; and so it goes on as just described.

We have thus given the particulars respecting one of the great cylinders, and its subsidiary supply-cylinder. The other of the pair is precisely similar. The two shafts, as usual, connect with a common working beam; and of course the rise of the piston on one side concurs with atmospheric pressure in producing a descent in that of the other.

The fire acts directly against the bottom of the large cylinders. When the engine is in full action, the air entering, say at a temperature of 60°, will be heated to 450° on passing through the regenerator, by taking up the heat left in the regenerator by the hot air that had just before passed out; and as 480° are all that are required, the balance is supplied by the fire. The air at 480°, on now leaving the cylinder, is cooled down to 90° F., or but 30° above the temperature before entering. So great is the effect of the regenerator that the temperature near the regenerator on the side next the cylinder, and that on the opposite side, in all cases differ by at least 350° F., when there are sufficient fires in the furnaces.

Mr. Ericsson makes the following statements:

"In regard to *loss of heat*, the result of ample trial has been, that at no time has the temperature of the escaping air exceeded that of the entering air by more than 30°. As this differential temperature exhibits the *positive loss of heat*, it becomes important to ascertain its amount in pounds of coal: the area of the supply piston is 2626 square inches, and its stroke two feet; hence $36\frac{4}{10}$ cubic feet of atmospheric air is supplied for each stroke, and therefore at 30 strokes 1092 cubic feet, and for both cylinders 2184 cubic feet per minute=131,040 cubic feet per hour. The weight of atmospheric air is nearly 13½ cubic feet to the pound, and hence it will be seen that 9706 pounds of air pass through the engine every hour. We know that one pound of coal will raise the temperature of 10 pounds of water 1100°; the specific heat of water being to that of air as 26 : 100, it will also be seen that $38\frac{4}{10}$ pounds of air will be elevated in temperature 1100° with one pound of coal; now the observed loss of heat in the engine being 30°, the fact will be established that the loss will be only one pound of coal for every 1408 pounds of air passed through the engine, which, on 9706 pounds, proves the actual loss of heat in both regenerators to be only $6\frac{8}{10}$ pounds of coal per hour; a pressure of 13 pounds being sustained in the receiver exerting 60 horse-power, with an actual waste of only 6·8 pounds per hour, it will be found that *two* ounces of coal per hour per horse-power is the quantity of fuel absolutely wasted in the process of transfer. The actual consumption of the engine is however, nearly 40 pounds per hour, which is thus proved by the foregoing to be chiefly carried off by radiation of heat; on a large scale much of that radiation will be prevented; as the machine stands, a horse-power is produced by a consumption of less than 11 ounces to the horse-power per hour.

"The following particulars are of considerable practical importance:

"1st. The valves *g* and *h* [for the ingress of air to the lower cylinder and egress from it] are *not* subjected to heat, the caloric being taken up by the wires before reaching the valves.

"2d. The temperature of the packing of the working pistons does not exceed boiling heat at any time.

"3d. As only a slow radiating fire is needed, it has been found that common whitewash, applied to the under side of the heater, remains for several weeks; this proves conclusively that the effect of the heat is quite harmless.

"4th. A hole of half an inch in diameter, kept open for several hours in the valve chest, does not sensibly affect the pressure in the air-receiver, so abundant is the supply of air; this fact has surprised all practical men who have seen the engine; it proves completely that the machine need not be perfectly air-tight, as supposed by many.

"5th. After putting a moderate quantity of fuel into the furnace, it has been found that the engine works with full power for three hours without fresh feed, and after removing the fires entirely, it has frequently worked for one hour."

We pass from these observations on the stationary test-engine to a few words on the ship, of which, Mr. Ericsson in his paper does not particularly speak.

In the ship Ericsson, there are 4 working cylinders, the diameter of each being 168 inches, and the stroke 6 feet. The diameter of the supply cylinders is 137 inches. Iron wire of one-sixteenth of an inch is used for the regenerator. The amount of coal consumed by the four furnaces per day, is 6 to 7 tons. The disks of the regenerators have each 500,000 meshes, and the temperature of the air within the working piston when in action is stated at 444° F. The valve cutting off the air on the up stroke is closed when the piston has risen $\frac{63}{100}$ths of the whole stroke.

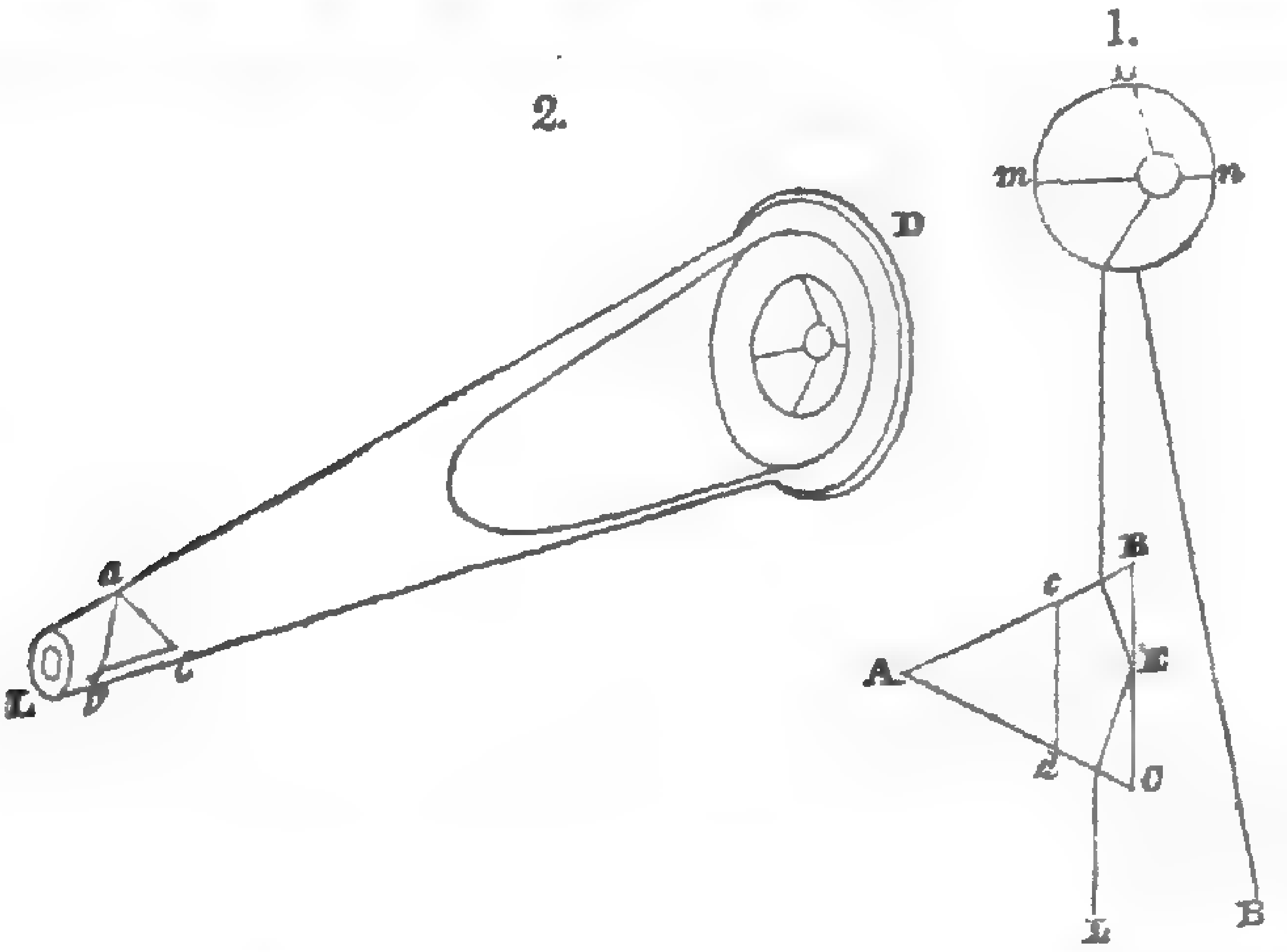
We do not at present undertake to discuss the probable success or failure of this important enterprise. We have been told that the ship draws with its present engines and without cargo or coal, 17 feet of water. It remains to be seen whether the increase of rapidity from 7 miles an hour to *fourteen* does not prove impracticable, as many fear and others hope; the contrary must be the desire of all well-wishers of humanity.

2. *Toronto Observatory.*—In the address of the president of the Canadian Institute at Toronto, Capt. J. H. Lefroy, we observe the announcement that the home government is about to withdraw from Canada "the military detachment by which a series of observations in magnetism and meteorology has been sustained in the neigborhood of Toronto since the year 1840." This removal will be a great misfortune to science, as it detaches Capt. Lefroy from his field of successful labor, in which the continent has had a deep interest; and especially so, if—as has been intimated to us—the fine collection of instruments by means of which these observations have been made during so considerable a number of years, should also be withdrawn from this continent and returned to England.

If its fate as a national observatory is sealed,—and it appears to be actually so,—we shall be gratified to learn that the local government of Canada, encouraged by the efforts and influence of its enlightened citizens, should favor the establishment of a Colonial Physical Observatory on the same basis, and if possible retain the valuable instruments now at Toronto. Were the undertaking to be sustained by the talent and science which we know to exist among the people of the province, as well as among military gentlemen occasionally resident in Canada, we cannot doubt that it would be successful in contributing largely, as heretofore, to the progress of physical science on this continent. For magnetic, meteorological and auroral observations, Toronto is one of the most important points in North America. We hope to hear that active efforts have been made for the establishment of such an Institution and we shall cordially wish it success.

The self-registering magnetical instruments that have been successfully used in Canada by Capt. Lefroy, are peculiarly excellent and exact in their records, and it is very desirable that similar instruments should be introduced at Washington, Cambridge, and other observatories in the United States.

3. *The Total-Reflexion Stereoscope*;* by Sir David Brewster, (Phil. Mag., [4] iii, 20.)—This form of the stereoscope requires only a small prism and *one* diagram, or picture of the solid, as seen by one eye; the other diagram, or picture which is to be combined with it, being created by total reflexion from the base of the prism. This instrument is shown in fig. 1, where D is the picture of a cone as seen by the left eye L, and ABC is the prism, whose base BC is so large that when the eye is placed close to it, it may see, by reflexion, the whole of the diagram D. The angles ABC, ACB must be equal, but may be of any magnitude. Great accuracy in the equality of the angles is not necessary; and a prism constructed by a lapidary out of a fragment of thick plate-glass, the face BC being one of the surfaces of the plate, will answer the purpose.† When the prism is placed at *abc*, fig. 2, at one end of a conical tube LD, and the diagram D, at the other end, in a cap which can be turned round so as to have the line *mn*, which passes through the centre of the base and summit of the cone parallel to the line joining the two eyes, the instrument is ready for use. The observer places his left eye at L, and views with it the picture at D, as seen by total reflexion from the base BC or *bc* of the prism, figs. 1 and 2, while with his right eye he views the same picture directly. The first of these pictures being the reverse of the second D, like all pictures formed by one reflexion, we thus combine two dissimilar pictures into a *raised* cone, as in the figure, or into a *hollow* one, if the picture at D is turned round 180°.


2.
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* The brief notice of this stereoscope on page 141 is incorrect.

† In this case the prism may have the form B*cd*C, fig. 1, the parallel sides BC, *cd* being the original faces of the piece of the plate-glass, and the inclined faces B*c*, C*d* only, the work of the lapidary.

If the conical tube LD is held in the left hand, the left eye must be used; and if in the right hand, the right eye must be used; so that the hand may not obstruct the direct vision of the drawing by the eye which does not look through the prism. The cone LD must be turned round slightly in the hand till the line *mn* joining the centre and apex of the figure is parallel to the line joining the two eyes. The same line must be parallel to the plane of reflexion from the prism; but this parallelism is secured by fixing the prism and the drawing.

It is scarcely necessary to state, that this stereoscope is applicable only to those diagrams and forms where the one image is the reflected picture of the other.

If we wish to make a microscopic stereoscope of this form, or to magnify the drawings, we have only to cement plano-convex lenses, of the requisite focal length, upon the faces AB, AC of the prism, or what is simpler still, to use a section of a deeply convex lens, and apply the other half of the lens to the right eye, the face BC having been previously ground flat and polished for the prismatic lens. By using a lens of larger focus for the right eye, we may correct, if required, the imperfection arising from the difference of paths in the reflected and direct pencils. This difference is so trivial, that it might be corrected by applying to the right eye the central portion of the same lens whose margin is used for the prism.

4. *Notice of a Chromatic Stereoscope;* by Sir David Brewster, K.H., F.R.S., V.P.R.S. Edin., (Phil. Mag., [4] iii, 31.)—In the year 1848, I communicated to the British Association, at Swansea, a brief notice of the principle of this instrument.*

If we look with both eyes through a lens, about 2½ inches in diameter or upwards, at an object having colors of different refrangibilities, such as the colored lines on a map, a red rose among green leaves, or any scarlet object upon a blue ground, or in general any two simple colors not of the same degree of refrangibility, the *two* colors will appear at different distances from the eye of the observer.

In this experiment we are looking through the margin of two semi-lenses or virtual prisms, by which the more refrangible rays are more refracted than the less refrangible rays. The doubly-colored object is thus divided into two as it were, and the distance between the two blue portions is as much greater than the distance between the two red portions (red and blue being supposed to be the colors) as *twice* the deviation produced by the virtual prism, if we use a large lens or two semi-lenses, or by the real prisms, if we use prisms.

The images of different colors being thus separated, the eyes unite them as in the stereoscope, and the *red* image takes its place nearer the observer than the *blue* one, in the very same manner as the two nearest portions of the dissimilar stereoscopic figures stand up in relief at a distance from their more remote portions. The reverse of this will take place if we use a concave lens, or if we turn the refracting angles of the two prisms inwards.

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* See Report of the British Association at Swansea, 1848, Trans. of Sect., p. 48.

Hence it follows, and experiment confirms the inference, that we give solidity and relief to plane figures by a suitable application of color to parts that are placed at different distances from the eye.

These effects are greatly increased by using lenses of highly-dispersing flint glass, oil of cassia, and other fluids, and avoiding the use of compound colors in the objects placed in the stereoscope.

5. *Spots on the Sun*, (L'Institut, No. 984.)—M. Rodolph Wolf writes with reference to the recently discovered periodicity in the spots on the sun, that he is engaged upon an extended memoir on the subject, which will comprise all of importance that is on record respecting the spots since their discovery, and the results of his own observations. He has examined some 400 volumes in looking out the history of the subject. In the first chapter of his memoir, he will deduce from 16 different ascertained epochs of minimum and maximum, that the mean period for the spots should be fixed at 11·111 ± 0·038 years, so that 9 periods are just equal to a century. In the second chapter he will show that for each century, the years 0, 11·11, 22·22, 33·33, 44·44, 55·56, 66·67, 77·78, 88·89, correspond to the minima of solar spots. The interval between the minimum and maximum is variable, but averages five years. The third chapter will contain a historical notice of all the records of spots from Fabricius and Scheiner to Schwabe, with reference to the period ascertained. The fourth chapter points out certain analogies between the solar spots and the variable stars. The fifth will be devoted to showing that the period of 11·11 years corresponds more nearly with the variations in magnetic declination, than the period of $10\frac{1}{5}$ years established by Lamont. The magnetic variations follow the spots not only in their regular changes but also in their minor irregularities. The sixth chapter will contain a comparison between the solar spots and meteorological notes and registers at Zurich between the years 1000 and 1800. It follows, conformably to the views of Herschel, that the years when the spots are most numerous are in general more dry and more fertile than the others, the latter being more stormy as well as moist. The aurora borealis and earthquakes increase in a striking manner with the increase of the spots.

6. *Meteor observed at Toulouse by M. Petit, and at Bordeaux by M. Abria*, (L'Institut, No. 978, Sept. 29, 1852.)—The calculations made from the observations show that the meteor was 253 kilometers[*] from the earth when seen at Bordeaux, and from Bordeaux at the same time 268 kilometers; and when seen at Toulouse it was 149½ k. from the earth. Apparent rapidity from M. Abria's valuation 214·4 k.; from M. Petit's, 62½ k. Absolute rapidity in space, from M. Petit, 75 k. The diameter according to M. Petit's observations was 215 meters (=235 English yards); and he concludes that the meteor was a cosmical body moving in space.

7. *On a new Meteoric stone from Gütersloh.*—Last year M. Dove presented to the Prussian Academy at Berlin a meteoric stone which fell at Gütersloh on the 17th of April, according to the testimony of Dr. Stohlman. M. Rose has since received another large piece from the same locality and a fragment weighing over three ounces was sent

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[*] A kilometer is 3280 English feet, or $\frac{62}{100}$ths of an English statute mile.

to the Academy by M. Stohlman. The cabinet of Meteorites at the Museum of Berlin contains meteorites from 97 localities, 33 of which are meteoric irons, and 64 meteoric stones. The whole known number of distinct meteoric irons according to Dr. Wm. S. Clarke now amounts to sixty.

OBITUARY.

Dr. Daniel Drake.—Dr. Drake died in Cincinnati, the city of his residence, on Saturday morning, November 7, being sixty-seven years old. He began the practice of medicine in Cincinnati, at the beginning of the present century, at which time that city was a village, with one brick house in solitary contrast to those of logs and boards about it.

Dr. Drake's name is the most eminent in the annals of Western medicine. His great work on the Diseases of the Valley of North America is the result of well-directed industry, and the most indefatigable research. The first volume only has yet been published. We trust that the second may be ready for the press, for otherwise his death will indeed be a double calamity to the public and to the profession. This work has been pronounced by competent medical critics to be one of high merit; and its foreign reputation is equal to that which it enjoys at home. It must ever remain an important portion of our permanent medical literature.

Apart from his labors in his profession, Dr. Drake, on various occasions, delivered lectures and orations on subjects of public interest, many of which have been published. They are marked by vigorous and original thinking, and by the practical value of their suggestions. They would afford materials for a valuable volume.

Dr. Drake was extremely fond of recalling the past. The scenes of his youth lived most vividly in his memory, and in his fervid descriptions, they glowed in all their original beauty and freshness. He was always ready to do justice to his cotemporaries; and in speaking of his own early and somewhat rough professional experience, he often brought in anecdotes creditable to those who were his competitors for the public favor. His memory was a store-house filled with an infinite variety of things both large and small, from the treatment of a hypochondriac patient fifty years ago, up to what had been written and said in relation to those great problems of humanity which have taxed the loftiest powers of the human mind in all ages.

In the decease of Doctor Drake, Cincinnati has lost one of her pioneer citizens, one of her greatest men, and the writer to whom she is most indebted for her prosperity. He dearly loved his city, which had grown up in the wilderness, immediately under his own eye. He had lived there when it was a little village, and he lived to see it a great city, the 'Queen of the West.' It is not strange then that he loved the city consecrated to his heart by affliction, by adversity and by prosperity—the city in which he had met with both success and suffering—where his affections had ripened, flourished and decayed—where the past was full of reminiscences of gladness as well as of gloom—where his home had been for half a century, a period marked by events of the highest importance.

As a lecturer on subjects connected with his profession, his reputation was unsurpassed by that of any of his coadjutors. As a medical lecturer, few have been engaged so long and so devotedly, while none have excited more general attention, or attracted a greater number of students anxious to listen to the wisdom which fell from his lips. He was, at the time of his decease, a member of the faculty of Ohio Medical College.

From what we know of his habits, we trust that he has left behind him ample materials for the construction of a biography. A well-written volume is due to his memory, and the incidents and the associations of his life will afford ample materials, full of interest and instruction. There are those still living who were his early associates and companions during the long period embraced by his professional life, and from them much may be gathered of deep interest in relation to our departed friend. He was always the friend of young men of talent and merit, and many are now on the stage of life who look back with feelings of profound gratitude to the generous sympathy and many kindnesses he showed them in their days of trial. He was not only a man of high talent, but he was also one of the most painstaking and laborious students that we have ever known. His success is mainly to be attributed to his unswerving diligence. He was never satisfied as long as he knew that he was ignorant of any of the phases of a subject. His example in this respect is valuable and ought to be followed by all those who aspire to fortune or to fame in their profession.

The facts in the above notice are somewhat abridged from an article published in a Cincinnati paper, and copied into the Louisville Weekly Journal. We believe them not to be exaggerated.

Dr. Drake was perhaps the first writer who called the attention of geologists to the drift and boulders in the vicinity of Cincinnati, and his little volume, in which the facts are contained, may still be read with advantage.
B. S. SR.,

PROF. C. B. ADAMS.—The steamer *Petrel*, which arrived at New York from St. Thomas, W. I., on Saturday, brought the sad intelligence of the death at that place, of Prof. C. B. Adams, of Amherst College. Prof. Adams had become widely known in the scientific world, by his labors in the departments of Geology and Zoology; and in his unexpected demise, Science has to mourn the loss of a most indefatigable and accurate investigator. For some years he performed the duties of State Geologist of Vermont, and his reports in that capacity have been published. In conjunction with Mr. Gray, of Brooklyn, he had just completed and published a valuable elementary work upon geology. In several visits which he had made to Jamaica, he had thoroughly studied the marine, fluviatile and terrestrial mollusks of that island, and enriched its Fauna by the publication of several hundred new species. Within a few years past his attention had become particularly directed to *Zoological Geography*, a field in which he saw that a rich harvest of scientific truth was yet to be gathered. The last volume of the Annals of the Lyceum of Natural History of New York, contains the result of his sojourn for a few weeks at Panama, in the Winter of 1850–51, in the form of a treatise upon the Zoological Province of Panama, with a catalogue of its mollusks, and full notes upon their geographical distribution. He had projected a similar but more elaborate work on the geographical distribution of the mollusks of the Caribbean Zoological Province, a work for which his previous visits to the West Indies had eminently qualified him. Impaired health rendering another visit to a warmer climate advisable, he had designed making this visit also subservient to the collecting of facts and material for his favorite object. But shortly after his arrival at St. Thomas, in December, he was attacked by the prevalent fever,—and when the friends around him hoped that he had passed the crisis of the disease, he suddenly sank from exhaustion, and died on the 19th of January.—*N. Y. Daily Times, Feb.* 1.

We have from time to time had occasion to notice the publications of Prof. Adams; and only in our last number we announced the appearance of his last great work, on the Mollusks of Panama, and the labors in which he was engaged in the neighboring seas. Some of the results of his investigations are embodied in the Paper in the preceding number (vol. xiv, p. 389) on the Geographical Distribution of Mollusca, by Mr. T. Bland.

SEARS C. WALKER.—This eminent astronomer and mathematician died on the 30th of January, 1853, at the residence of his brother, Judge Walker, on East Walnut Hills, near Cincinnati, Ohio.

Sears C. Walker was born at Wilmington, Mass., on the 28th of March, 1805; graduated at Harvard University in 1825; taught a private school in Philadelphia for several years; was for a considerable period actuary in the Pennsylvania Life Insurance Company; a short time attached to the National Observatory, but for several years preceding his death was one of the assistants of the U. S. Coast Survey.

As a child, his precociousness was the wonder of the village. At College, he was remarkable for his aptness in acquiring languages. Afterwards he became an enthusiastic devotee of science. The archives of the American Philosophical Society, Franklin Institute, Smithsonian Institution, and other learned societies here and in Europe, all attest a zeal for scientific research, which has at last resulted in his martyrdom. For the last three or four years, apart from his regular duties in the coast survey—of themselves sufficiently arduous—he has borrowed from needful rest so many hours, in order to discover the orbit and make the ephemeris of Neptune, and to determine the velocity of the transmission of the fluid along the telegraph wires, that about a year ago his brain gave way, and he was for several months in a lunatic asylum. In October last, he was thought to be so far recovered as to justify his removal from the asylum, and he came to Cincinnati on a visit to his brother. Here he gradually resumed his labors, both in computations for the coast survey and in the preparation of an ephemeris of Neptune for the American Nautical Almanac. In December, he had made all his preparations to depart for Washington, and resume his regular duties there as chief of a party in the survey, when an attack of bilious fever frustrated all his plans. From this fever he seemed to have recovered, but his frame again gave way, and this time without hope of a second rally.

In the circles of science, both here and abroad, his death will be deeply felt; for he had with them an extensive correspondence and a growing reputation. But beyond these, and his own family circle, he was little known. In politics he never mingled. For the ordinary amusements and excitements of the world he had no taste. His one absorbing passion was a love of science, and that for its own sake. Seldom has there been a man so highly gifted, of more retiring modesty, or greater meekness and simplicity of character.—*Cin. Gaz., Feb.* 1.

[We subjoin the following sketch of Mr. Walker's scientific labors, given at a meeting of the officers and members of the U. S. Coast Survey, by Prof. A. D. Bache, Superintendent.—Eds.]

We have met to pay our tribute of respect and feeling to one of our most distinguished and valued associates, Sears C. Walker, Esq., whose failing health for more than a year past has kept us in anxiety and fear for the result which has now come. Mr. Walker was attacked by bilious fever some weeks since; and though his mind was clear, his physical strength was not adequate to resist the effects of the disease.

The services which Mr. Walker has rendered to the coast survey are known in a general way to most of those whom I address. He had made the largest collection of American observations of moon culminations and occultations ever made in the country, and prepared to discuss them thoroughly for longitudes, and to bring them to bear, as far as applicable, by the geodetic results of the coast survey, upon the longitude of a central point. The magnitude of this labor would have appalled an ordinary mind. He knew that by perseverance it could be accomplished. During this discussion he reached the conclusion that the longitudes from moon culminations could not be reconciled with those from occultations, and that the theory must be reëxamined for an explanation. His published reports show the successive steps of his investigation, which was not completed at the time of his decease. In the midst of it, the new, attractive, and important subject of determining differences of longitnde by the telegraph was committed to him, and he threw all his zeal and knowledge into the solution of this problem, and brought it to the successful condition in which it now is. He early saw the impossibility of reading a near result by merely repeating the transmission and reception of signals, beats of a clock or chronometer, and that the beats sent and received must be of time-keepers regulated to different times—as, for example, mean solar and sidereal, and seized all the consequences flowing from this principle. The telegraphing of transits of stars was original with him.

He soon became satisfied of the necessity for graphic registry of the time results, and invited the coöperation of Mr. Saxton, of Mr. Bond, of Prof. Mitchell, and of Dr. Locke in the solution. With him originated the application of this method to the registry of time observations for general astronomical purposes, now developed by so many ingenious modes, and known as the "American Method." His researches on galvanic wave-time, growing out of these experiments for difference of longitude, are by far the most valuable contributions yet made to this branch of science. In this subject alone Mr. Walker accomplished a most remarkable five years' work; but this was only a part of what his mind found there to do, and, aside from this and labors of daily and nightly routine in computing and observing, he accomplished a work—investigation of the orbit and computation of an ephemeris of Neptune—which of itself would have given him an undying reputation. I cannot in this place describe how the training of a life was obtained which led to these brilliant results for our work, and for American science; nor can I trust myself now in an analysis of the mind and heart of this friend for many years. I have faintly pencilled his doings while closely connected with our work, shadowing merely his claims to our admiration, respect, and gratitude.—*Republic*, *Feb.* 8.

William MacGillivray.—This distinguished naturalist had just completed the fourth and fifth volumes of his History of British Birds, before his death in September last. He was already on the brink of the grave when his work was completed; and his concluding message to his readers is his farewell to the world. He closes with the following noble sentiments. "I have been honest and sincere in my endeavors to promote the truth. With death, apparently not distant, before my eyes, I am pleased to think that I have not countenanced error, through fear or favor. Neither have I in any case modified my sentiments so as to endeavor thereby to conceal or palliate my faults. Though I might have accomplished more, I am thankful for having been permitted to add very considerably to the knowledge previously obtained of a very pleasant subject. If I have not very frequently indulged in reflections on the power, wisdom, and goodness of God, as suggested by even my imperfect understanding of his wonderful works, it is not because I have not ever been sensible of the relation between the Creator and his creatures, nor because my chief enjoyment when wandering among the hills and valleys, exploring the rugged shores of the ocean, or searching the cultivated fields, has not been in a sense of His presence. 'To Him who alone doeth great wonders,' be all glory and praise. Reader, farewell."*

The first three volumes of his work on British birds were published in 1837. Besides this, his great work, he published various memoirs on birds in the Wernerian Transactions and elsewhere; the "Conchologist's Text-Book," which passed through six editions; a "History of the Molluscous Animals of the counties of Aberdeen, Kincardine, and Banff;" a "Manual of Geology," a volume on "British Quadrupeds," forming the seventh of Jardine's Naturalists Library, besides various other works and memoirs.

VII. BIBLIOGRAPHY.

1. *Report on the Geology of the Lake Superior Land District;* by J. W. Foster and J. D. Whitney, U. S. Geologists. Part II. The Iron Region together with the General Geology. 406 pp., 8vo. Senate Document, Special Session, March, 1851; Executive No. 4.—The first part of Messrs. Foster and Whitney's Geological Report was noticed at some length in vol. xii, (p. 222) of this Journal. This second part enters more fully into geological details and principles, and embraces observations of the highest value to the science. Many points in the geology of the United States are ably discussed, and established as a

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* Athenæum, 1852, p. 998.

part of the now known history of ancient epochs in this hemisphere. Among these, is the age of the extensive red sandstone formation of the Lake Superior region, which more from its intersection by trap dykes rather than from any other reason, was formerly referred to the same age with the Connecticut river red sandstone. It appears to be settled that these rocks, as Messrs. Foster and Whitney announced in the first part of their Report, are as old as the lowest Silurian. The occurrence of Lingula and Trilobites in this group, must be considered, the authors observe, as conclusively settling its age. Mr. Logan of Canada, from surveys there made, announces that the evidence is clear and indisputably conclusive.

The volume presents in the third, fourth and fifth chapters, a full exhibition of the characters of the azoic system which they recognize as existing in this and other countries below the lowest Silurian or Cambrian. The Trap Rocks, Lower Silurian system, Upper Silurian and Devonian systems with their Fossils, are treated with fullness in chapters 6 to 13; part of which are by the learned palæontologist, Mr. James Hall. Chapters 15 and 16 on Superficial Deposits, are by Mr. E. Desor. Chapter 17 takes up the subject of the Elevation of Mountain Chains, in which the views of Elie de Beaumont are accepted. Chapter 18, by James Hall, discusses the Parallelism of the Palæozoic Deposits of Europe and America. The following pages are upon the fluctuations of the surfaces of the lakes, by C. Whittlesey; magnetic variations and comparison of Terrestrial and Astronomical Measurements, by C. Whittlesey; and the Botany of the Region, by W. D. Whitney. The volume is abundantly illustrated, and twelve plates are devoted to fossils. There are also three large folded maps, forming a separate thin octavo volume.

2. *Report of a Geological Survey of Wisconsin, Iowa and Minnesota, and incidentally of a portion of Nebraska Territory, made under Instructions from the United States Treasury Department*; by DAVID DALE OWEN, U. S. Geologist. 638 pp., 4to, with numerous wood-cuts, and a 4to volume of plates and maps. Philadelphia, 1852.—The Report of Dr. Owen is elegant in its typography and illustrations and able in its science. The author, among the first of American geologists, has contributed in his Report very largely to our knowledge of the rocks and fossils of the West, and to the general progress of geological science. The volume gives elaborate descriptions of the geological formations of the Upper Mississippi, taking up the several rocks in order, describing their features, materials, fossils, range, extent, and economical bearing.

Next follow Dr. J. G. Norwood's Report on the Geology of Middle and Western Minnesota; Col. Whittlesey's Report on Wisconsin south of Lake Superior; Dr. B. F. Shumard's Report on Geological Sections of the St. Peter's, Mississippi, Wisconsin, Barraloo, Snake and Kettle River; Dr. Joseph Leidy's Memoir on the Fossil Mammalia and Reptilia collected during the survey, in which are descriptions of several new genera as well as species. An Appendix on the fossils, and additional chemical examinations by the author, with a catalogue of plants by C. C. Parry, and birds by H. Pratten, close this large and most important volume. The quarto volume of plates, contains fifteen plates of fossils, of unusual beauty, (seven of which are devoted to the remarkable mammalia from the Eocene tertiary of Nebraska,) besides various views, sections and maps. We might interest our readers with extended citations from its pages, but can add in this place only the following extracts relating to

The general features and ancient Mammalia of the Mauvaises Terres of Nebraska.

"After leaving the locality on Sage creek, [a southern branch of the Cheyenne,] affording the above-mentioned fossils, [fossil ammonites, &c. of the Eocene tertiary,] crossing that stream, and proceeding in the direction of White river, about twelve or fifteen miles, the formation of the Mauvaises Terres proper bursts into view, disclosing, as here depicted, one of the most extraordinary and picturesque sights that can be found in the whole Missouri country.

From the high prairies, that rise in the background, by a series of terraces or benches, toward the spurs of the Rocky Mountains, the traveller looks down into an extensive valley, that may be said to constitute a world of its own, and which appears to have been formed, partly by an extensive vertical fault, partly by the long-continued influence of the scooping action of denudation.

The width of this valley may be about thirty miles, and its whole length about ninety, as it stretches away westwardly, towards the base of the gloomy and dark range of mountains known as the Black Hills. Its most depressed portion, three hundred feet below the general level of the surrounding country, is clothed with scanty grasses, and covered by a soil similar to that of the higher ground.

To the surrounding country, however, the Mauvaises Terres present the most striking contrast. From the uniform, monotonous, open prairie, the traveller suddenly descends one or two hundred feet, into a valley that looks as if it had sunk away from the surrounding world; leaving standing, all over it, thousands of abrupt, irregular, prismatic, and columnar masses, frequently capped with irregular pyramids, and stretching up to a height of from one to two hundred feet, or more.

So thickly are these natural towers studded over the surface of this extraordinary region, that the traveller threads his way through deep, confined, labyrinthine passages, not unlike the narrow, irregular streets and lanes of some quaint old town of the European continent. Viewed in the distance, indeed, these rocky piles, in their endless succession, assume the appearance of massive artificial structures, decked out with all the accessories of buttress and turret, arched doorway and clustered shaft, pinnacle, and finial, and tapering spire. One might almost imagine oneself approaching some magnificent city of the dead, where the labor and the genius of forgotten nations had left behind them a multitude of monuments of art and skill.

On descending from the heights, however, and proceeding to thread this vast labyrinth, and inspect, in detail, its deep, intricate recesses, the realities of the scene soon dissipate the delusions of the distance. The castellated forms which fancy had conjured up have vanished; and around, on every side, is bleak and barren desolation.

Then, too, if the exploration be made in midsummer, the scorching rays of the sun, pouring down in the hundred defiles that conduct the wayfarer through this pathless waste, are reflected back from the white or ash-colored walls that rise around, unmitigated by a breath of air, or the shelter of a solitary shrub.

The drooping spirits of the scorched explorer are not permitted, however, to flag. The fossil treasures of the way, well repay its sultriness and fatigue. At every step, objects of the highest interest present themselves. Embedded in the debris, lie strewn, in the greatest profusion, organic relics of extinct animals. All speak of a vast fresh-water deposit of the early Tertiary Period, and disclose the former existence of most remarkable races, that roamed about in bygone ages high up in the Valley of the Missouri, towards the sources of its western tributaries; where now pastures the big-horned *Ovis montana*, the shaggy buffalo or American bison, and the elegant and slenderly constructed antelope.

Every specimen as yet brought from the Bad Lands, proves to be of species that became exterminated before the mammoth and mastodon lived, and which differ in their specific character, not alone from all living animals, but also from all fossils obtained even from cotemporaneous geological formations elsewhere.

Along with a single existing genus, the Rhinoceros, many new genera never before known to science have been discovered, and some, to us at this day, anomalous families, which combine in their anatomy structures now found only in different orders. They form, indeed, connecting links between the pachyderms, plantigrades, and digitigrades. For example, in one of the specimens from this strange locality, described by Dr. Leidy under the name of *Archæotherium*, we find united characters belonging now to the above three orders; for the molar teeth are constructed after the model of those of the hog, peccary, and babyroussa; the canines as in the bear; while the upper part of the skull, the cheek-bones, and the temporal fossa assume the form and dimensions which belong to the cat tribe. Another, the *Oreodon* of Leidy, has grinding teeth like the elk and deer, with canines resembling the omnivorous thick-skinned animals; being, in fact, a race which lived both on flesh and vegetables, and yet chewed the cud like our cloven-footed grazers.

Associated with these extinct races, we behold also, in the Mauvaises Terres, abundant remains of fossil pachydermata, of gigantic dimensions, and allied in their anatomy to that singular family of proboscidean animals, of which the tapir may be taken as a living type. These form a connecting link between the tapir and the rhinoceros; while, in the structure of their grinders, they are intermediate between the daman and rhinoceros; by their canines and incisors, they connect the tapir with the horse, on the one hand, and with the peccary and hog on the other. They belong to the same genus of which the labors of the great Cuvier first disclosed the history, under the name of *Palæotherium*, in publishing his description of the fossil bones exhumed from the gypsum quarries of Montmartre, near Paris, but are distinct in species; and one, at least, of this genus, discovered in the Bad Lands (*Palæotherium Proutii*), must have attained a much larger size than any which the Paris basin afforded. In a green, argillo-calcareous, indurated stratum, situated within ten feet of the base of the section, a jaw of this species was found, measuring, as it lay in its matrix, five feet along the range of the teeth, but in such a friable condition, that only a portion of it could be dislodged; and this, notwithstanding all the precautions used in packing and transportation, fell to pieces before reaching Indiana." * * * *

The author continues with remarks on other Fossil Mammalia from this singular region. Descriptions of the above and other fossils, including four species of Fossil Turtle, are given in the chapter by Dr. Leidy.

With regard to the Lake Superior Sandstone, Mr. Owen arrives at the same conclusion essentially with Messrs. Foster and Whitney, that it is as old at least as the lowest Silurian. Dr. Owen even suggests that it probably underlies the Lingula and Orbicula beds of the Upper Mississippi valley.

3. *A History of Infusorial Animalcules, living and fossil, illustrated by several hundred magnified representations;* by ANDREW PRITCHARD, M.R.I., &c. A new edition, enlarged. London: 1852.—In preparing the new edition of this useful work, Mr. Pritchard has been aided by J. T. Arlidge, and the result of their united labors has been the production of a volume containing a large amount of new and interesting matter in addition to the contents of the preceding edition. Without increasing the cost of the work, the number of engravings has been doubled, and many additions have been made to the text. Among these are compilations from Ehrenberg's numerous papers read before the Berlin Academy, including the description of many new genera and species. The admirable work of Ralfs on the Desmidieæ has been adopted as the basis of the chapter on these forms, while other valuable matter is drawn from the Annals and Magazine of Natural History, and from the writings of Kütsing, Dujardin, Siebold, Stein, &c. In fact, great industry appears to have been exerted in collecting every thing novel relating to the Infusoria. We must however, express our regret that the editors have not devoted more time to the arrangement and connection of the heterogeneous materials thus assembled. It is true that it well represents the present state of this department of science, in which all is in confusion. But there are parts of the subject which are no longer doubtful, and we regret that we are presented with many erroneous generic and specific characters taken from the now obsolete descriptions of Ehrenberg, Kütsing and others. We allude more particularly to the constant allusion to "*apertures*" in the shells of the Diatomaceæ, and to the application of the term "*smooth*" to the surface of various siliceous shells which may readily be shown to be lined objects by a good objective of even one inch focal distance. We observe that Schleiden's denial of the existence of apertures in the Navicula, &c. is given, and also his assertion that the so-called apertures are merely depressions, while Dujardin considers them as elevations of the surface of the shell; but the editors appear to have overlooked the decision of these questions afforded by the action of hydrofluoric acid, (see this Journal, xi, 349,) by means of which it has been put beyond all doubt that the apertures have no existence, and that what have borne this name are neither elevations nor depressions merely, but in reality the thickest portion of the shells. As many of

Ehrenberg's generic characters, as well as Kütsing's classification of the Diatomaceæ into Astomaticæ and Stomaticæ are founded on errors with regard to these supposed apertures, their descriptions as quoted in this volume, require important corrections. With regard to many a species described as smooth, and indeed not only as "levis," but "levissima," by Ehrenberg and by Kütsing, we do not hesitate to assert that not one of them is smooth. In fact, a Diatomaceous shell on which no markings can be made out by Spencer's best lenses is yet to be sought for. We would not be understood to cast any censure upon the great German writers above mentioned, for their erroneous observations were made many years since, with instruments so poor that it is only to be wondered at that they accomplished so much with them. Three years after the publication of Ehrenberg's great work in 1838, it was thought a matter worth recording in the London Microscopic Journal (see vol. ii, p. 224,) that the Navicula Hippocampus, Ehr., mounted dry, could be made to show transverse lines by careful management of the light, while at present it is considered as one of the coarsest of the test objects furnished by the Naviculæ.

In connection with this subject, we quote the following remarks in which the difficulty of resolving the markings on the Diatomaceous test objects is greatly overrated. The authors state that "those who make the structure of these shells a special study, require from forty to fifty minutes manipulation with a first rate instrument, and all the modern appliances for obtaining intense oblique light, before they can shew certain striæ or dots on a well known specimen." Now we know by numerous trials made with Spencer's objectives upon the most difficult test object now known, viz. the Grammatophora from Providence, R. I., that after the shell to be examined is once brought into the field of view, two minutes is a very large allowance of time for the exhibition of its markings by sunlight, and this too, without any of the ingenious appliances for oblique illumination, on which the London artists have lately devoted so much labor.

We regret to see numerous typographical errors in this edition, and among others one on page 102 which deprives Spencer of the credit of 30° of aperture beyond what is there stated. Instead of his objective having an angle of 147° as there stated, it should be 174°*.

Although we have thus pointed out some faults of this edition, we yet can sincerely say that there is no work extant in which so much valuable information concerning the Infusoria can be found, and every microscopist should add it to his library.

4. *On the Origin of the Forms and Present Condition of some of the Clusters of Stars and several of the Nebulæ;* by STEPHEN ALEXANDER, Prof. Math. and Astron. in the College of New Jersey, (from the Astronomical Journal, Nos. 36 to 44, 1852.)—The plates illustrating this remarkable paper represent various nebulæ as developed by the recent telescopes of Lord Rosse, Herschel and other observers. Some are simple elliptical clusters, with a brighter center; others consist of two or three rings with an irregular fringe to the exterior; some are literally broken rings; others are like dumb-bells; others like a

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* See this Journal, 2nd Ser., vol. xiii, p. 31.

comma in form, having a circular head, produced on one side into a long spirally curving extremity. And others seem like tornadoes in the heavens, whose currents rushing spirally about a center carry worlds in their course in place of clouds of dust. Col. Sabine states in his recent address before the British Association, that no known laws of force have hitherto been found sufficient to explain the strange mode of aggregation of worlds exhibited by nebulæ. Prof. Alexander has undertaken to review and compare these various forms, and endeavors to trace their correspondence with the nebular theory, extending and modifying it so as to embrace the universe. He concludes that the clusters of stars and nebulæ are "*the partially scattered fragments of enormous masses, once rotating in a state of dynamical equilibrium; and that the separation of these fragments may still be in progress.*" The author, after some observations on the motions and conditions of a homogeneous fluid mass and the rates essential to its preserving a spheroidal form, takes up the classes of nebulæ in order, and points out the processes of development through which they may be supposed to have passed. He considers first those whose original form was a highly oblate spheroid, under which fall the spirals and elliptic nebulæ; second, those in which the original was a spheroid of small ellipticity; third, those having for the primitive or early derivative form a ring, besides other varieties. The milky way is compared to one of the spirals. We should do injustice to the author by any abstract we might make of his paper, especially without his elegant plates, and we, therefore, refer our readers to the paper itself in the Astronomical Journal.

5. *Chemical Field Lectures for Agriculturists;* by Dr. JULIUS ADOLPHUS STÖCKHARDT, Prof. in the Royal Acad. of Agric., at Tharand. Translated from the German. Edited with notes by JAMES E. TESCHEMACHER. 242 pp., 12mo. Cambridge, 1853: J. Bartlett.—Prof. Stöckhardt's work consists of Lectures or Chapters on practical subjects connected with Agriculture—viz.: the Nourishment of Plants—Increasing the Growth of Plants by Manuring—Excrements and Urine as manures—Drainings—Stall-manure and Straw—Importance and value of Artificial Manures—Guano—Bones—Oil Cake—Malt grains or Refuse from Breweries. The author has presented these subjects in a style as free as possible from scientific technicalities, and made a work highly useful to the farmer and horticulturist, rendering science in fact the companion and servant of man in his labors with the soil. Mr. Teschemacher, who has much practical and scientific acquaintance with guano and other fertilisers, has added much to the value of the work by various notes through the volume.

6. *Principles of Human Physiology, with their chief applications to Psychology, Pathology, Therapeutics, Hygiene and Forensic Medicine;* by WM. B. CARPENTER, M.D., F.R.S., F.G.S., Examiner in Physiology and Comparative Anatomy in the University of London, &c. Fifth American from the fourth and enlarged London edition, with 314 illustrations. Edited with additions by FRANCIS GURNEY SMITH, M.D., Professor of Medicine in the Medical Department of Pennsylvania College, &c. 1091 pp., 8vo, 1853. Philadelphia.—Carpenter's Human Physiology is too well known and too highly appreciated to need commendation. This new edition by Lea and Blan-

chard has received many and large additions, increasing very much its value. It makes the previous editions appear altogether antiquated. The author in his Preface, observes "that on commencing the preparation of the new edition (fourth) he found that nothing short of an entire remodelling of the preceding edition would in any way satisfy his notions of what such a treatise should be." He was led therefore to the production of literally a new treatise. The changes have made a more thorough, systematic and practical work. A chapter, on the chemical components of the human body and the changes which they undergo within it, is entirely new; and another on the structural elements of the human body and the vital actions which they exhibit, is mostly so. The changes also in the chapter on the functions of the nervous system are very extensive and important.

7. *Industrial Drawing, comprising the Description and Uses of Drawing Instruments, the Construction of Plane Figures, the Projections and Sections of Geometrical Solids; Architectural Elements, Mechanism and Topographical Drawing; with remarks on the Method of teaching the subject. For the use of Academies and Common Schools;* by D. H. MAHAN, LL.D., Professor of Civil Engineering, &c., &c., in the U. S. Military Academy. 156 pp., 8vo. New York, 1852: J. Wiley.—The ability and thoroughness of the works of Prof. Mahan of West Point are well known. This volume is one much needed and is well adapted for its end. It enters into the principles and practice of drawing in all its various departments, even to forms of complex character, and illustrates the subject by various plates.

8. *American Polytechnic Journal, devoted to Science, Mechanic Arts and Agriculture;* conducted by Prof. C. G. PAGE, J. J. GREENOUGH, M.E., and CHAS. C. FLEISCHMANN, C.E. Vol. I, No. 1, Jan., 1853. 80 pp., large 8vo. A monthly at $3,00 per annum.—The promised appearance of this Journal was announced in our last. The number for January opens with some important papers on electro-mechanics by Prof. Page. Practical chemistry, especially relating to metals and alloys, occupy eight or ten pages. Several subjects connected with patents are next treated of, and among them "Patents for Improvements in making Sugar." Articles on agriculture, vine culture, merino sheep, and various miscellaneous articles of practical value or general interest close the number. This Journal will be found highly useful to all engaged in the mechanic arts, to any who are interested in patents or inventions, to the miner and worker in metals, to the agriculturist, and not less, to the man of science or general reader. Besides original papers, it presents records of recent discoveries both in this country and Europe, and also full lists of patents issued in the United States, with explanations or details of those of special importance.

9. *Sixth Annual Report of the Board of Regents of the Smithsonian Institution, to the Senate and House of Representatives, showing the Operations, Expenditures and Condition of the Institution during the year* 1851, *and the Proceedings of the Board of Regents up to date.* 104 pp., 8vo. Washington, 1852.—This institution is pursuing a noble course in its publication of original works and memoirs that constitute a real advance in knowledge. It is thus becoming a rich source of new truths from which all may draw who wish to promote the general enlightenment and progress of the country. We not un-

frequently hear complaints that the funds are not mainly used for the *diffusion* of knowledge. But the simple fact, as the Secretary states, that a single Patent Office Report often costs three time as much as the whole income of the Smithsonian fund, shows how utterly impossible it is to make this its prominent object. The Patent Office volume, notwithstanding the expenditure, is seen by few, and a complete series of the Reports is to be found in but a *very* small number of the libraries in the land.

10. *On the Extinct Species of American Ox*, from the Smithsonian Contrib., vol. v; *Description of an Extinct Species of American Lion, Felis atrox, and a Memoir on the Extinct Dicotylinæ of America*, from the Transactions of the American Phil. Soc., vol. x; by JOSEPH LEIDY, M.D. 4to, with 9 lithographic plates.—Dr. Leidy has made large contributions to our knowledge of the ancient Mammalia of this country. Twenty species of large quadrupeds have been named by him from the Nebraska Tertiary alone, ten of which, including two of rhinoceros, are described in Dr. Owen's Geological Report, noticed on a preceding page. The memoirs whose titles are above cited, contain descriptions of other species. Of American Fossil Ox, he enumerates 4 species, *Bison latifrons*, L., (Bos latifrons, *Harlan*,) Bison antiquus, L., Bootherium (L.) cavifrons, L., (Bos Pallasii, *De Kay*,) B. bombifrons, L., (Bos bombifrons, *Harlan*.) The second paper is the first announcement as yet made of an American Lion, and the species which he calls the *Felis atrox* was much larger than the recent tiger or lion, or the extinct *Felis spelæa* of Europe. It is from Natchez, Miss. The third paper presents a review of the species with many anatomical details of the Dicotylinæ which take the place in America of species of Sus. The lithographic plates illustrating these papers are excellent, and exhibit minute care and precision in the drawings.

11. *Proceedings of the Academy of Natural Sciences of Philadelphia.*—The Proceedings of the Academy are issued every two months and make every two years, a volume of 350 to 400 pages. They contain a large amount of matter on Zoology and other sciences, including numerous descriptions of new species, and announcements of new facts, or principles, by some of the ablest scientific investigators in the United States. They are sent to subscribers for the small charge of $1 per annum, in advance, this amount barely covering the cost of publication. Five volumes have been issued and the *sixth* is now in progress. Price for the first five volumes 8 dollars. Address Dr. Wm. S. Zantzinger, or W. S. Vaux, Esq., Philadelphia.

C. M. WETHERILL, Ph. D.: Chemical Examination of Two Minerals from the neighborhood of Reading, Pa., and on the occurrence of Gold in Pennsylvania; and on a new variety of Asphalt, Melan-asphalt. From the Trans. Amer. Phil. Soc., 8 and 8 pp. 4to.—These and other papers of Dr. Wetherill we shall cite from in our next.

N. S. MANROSS: Experiments on the Artificial production of Crystallized Minerals; an Inaugural Dissertation on Promotion to the rank of Doctor of Philosophy at the Georgia Augusta University. 32 pp., 8vo. *Göttingen*, 1852.—This important paper is the result of researches in the Laboratory of Prof. Wöhler. Other papers on hand have prevented our inserting it in the present number of our Journal.

THE COUNTRY GENTLEMAN: A weekly Journal for the Farm, the Garden and the Fireside, of 16 pp. 4to. Published at Albany, New York, by Luther Tucker, and devoted to The Farm, The Garden and Orchard, Rural Architecture, The Fireside, &c. Price $2 a year if paid in advance—$2 50 if not paid in advance.

C. Girard: Bibliographia Americana Historico-Naturalis, for 1851, 60 pp., 8vo. December, 1852. Published by the Smithsonian Institution.

C. MacFarlane: Japan; an account, Geographical and Historical, with numerous illustrations. 365 pp., 12mo. *New York*, 1852. G. P. Putnam & Co.

H. T. Tuckerman: Sicily, a pilgrimage. 187 pp., 12mo. *New York*, 1852. G. P. Putnam.

Proceedings Boston Soc. Nat. History.—NOVEMBER, 1852.—p. 226. On some peculiarities of the economy of reproduction in certain insects; *W. I. Burnett.*—p. 228. On New Ascidia from the U. S. coast; *M. Stimpson.*—Observations on some Moa bones; *Dr. Kneeland.*—p. 240. Note on Alligators teeth; *J. Wyman.*—DECEMBER.—On a nest of the Bream (Pomotus vulgaris) in gravel at the bottom of a pond; *C. T. Jackson.*—p. 243. Two new genera and three new species of Holothuria; *W. O. Ayres.*—p. 247. On the crystalline lens and its formation; *W. I. Burnett.*—p. 248. On two new Ophiuridæ, from the coast of South Carolina; *W. O. Ayres*—p. 252. On the crystalline lens.

Proceedings of the Academy of Nat. Sci. Philadelphia, Vol. VI, No. 4, 1852.—P. 117. Bos. latifrons of Harlan, found on the Ohio river, and proved to be a Bison; a note on the species of Megalonyx, Megatherium, and Mylodon; the Megalonyx Jeffersonii of Owen a new genus, Gnathopsis Oweni; *J. Leidy.*—p. 118. Note on Fusulina on the Missouri; *Dr. Owen.*—Note on the fish of Cold Pond, N. H.; *S. Weber.*—p. 119. Phenixville Molybdate of Lead; Chemical examination of the food of the Queen bee; *C. M. Wetherill.*—p. 121. Rhodophyllite, a new mineral; *F. A. Genth.*—p. 125. New Reptiles in the Museum of the Smithsonian Institution, 2nd part (Holbrookia 3 species, Crotaphytus 2, Uta 1, Sceloporus 4, Cnemidophorus 6, Plestiodon 1, Elgaria 1); *S. F. Baird* and *C. Girard.*—p. 129. Remarks on the Coccinellidæ of the United States; *J. L. Le Conte*—No. V.—p. 149. A new species of Sciurus; *J. L. Le Conte.*—p. 149. Synopsis of the Scydmænidæ of the United States; *J. L. Le Conte.*—p. 163. Catalogue of the Melyrides of the United States and descriptions of new Species; *J. L. Le Conte.*—p. 173. New Reptiles in the Museum of the Smithsonian Institution, 3d part, (Amblystoma 1 species, Rana 1, Bufo 2); *S. F. Baird* and *C. Girard.*—p. 174. Descriptions of New Reptiles collected by the U. S. Expl. Exp. under Capt. C. Wilkes, 1st part, species from the west coast of America (Amblystoma 1 species, Rana 2, Hyla 1, Bufo 1, Sceloporus 3, Elgaria 3, Tropidonotus 1, Wenona (nov. gen.) 2, Calamaria 1, Crotalus 1, Emys 1); *S. F. Baird* and *C. Girard.*—p. 177. New Species of Reptiles inhabiting North America (Tropidonotus 2 species, Phrynosoma 1, Sceloporus 2; Psammaphis 1, Elgaria 1, Homalosaurus (nov. gen.) 1, Crotalus 1, Pityophis, *Holbrook* 1, Leptophis 1, Bufo 1, Anota (nov. gen.) 1); *E. Hallowell.*—p. 182. Ibid. from Oregon (Tropidonotus 1; Hyla 1); *E. Hallowell.*—p. 184. New Birds in the collection of the Academy of Natural Sciences of Philadelphia, (Ammodromus 1 species, Emberiza 1, Spermestes 2, Ephialtes 2, Larus 1, Mergus 1, Anser 1)—Catalogue of the Halcyonidæ in the collection of the Academy; *J. Cassin.*—No. VI.—p. 189. Observations on the geology of Minnesota, etc.; *D. D. Owen.*—p. 192. On some Tertiary shells of the Southern States; *M. Tuomey.*—p. 194. On a new species of Numineus; *S. W. Woodhouse.*—p. 198. Remarks on the Tertiary strata of St. Domingo and Vicksburg, Miss.; *T. A. Conrad.*—p. 199. Notes on shells and descriptions of some new species; *T. A. Conrad.*—p. 200. On new pouched rats of the genera Perognathus and Geomys; *S. W. Woodhouse.*—p. 202. On a new Struthus; *S. W. Woodhouse.*—p. 203. On a new genus (Dinophis) and two new species of African serpents (Dinophis Hammondii and Dendrophis flavigularis); *E. Hallowell.*—p. 206. New North American Reptiles (Lamprosaurus 1 species, Crotaphytus 1, Tropidonotus 1, Ambystoma 1)—on a probably new element with Iridosmine and Platinum from California; *F. A. Genth.*—p. 210. Two new Owls from Wisconsin; *P. R. Hoy.*—p. 212. Analysis of the cotton plant and seed; *T. J. Summer.*

Proceedings of the American Philosophical Society, Vol. V, July 1851 to February 1852, No. 47.—p. 219. Correspondence of Mr. Lea and Prof. Agassiz on the Naiades.—p. 241. On a vein of Asphaltum at Hillsborough, N. B.; *R. C. Taylor.*—p. 252–257. On the collection of fine wool presented by the king of Saxony to P. A. Browne.—p. 262. Note on the Protococcus nivalis; *Mr. Justice.*—On specimens of vegetable matter found by him on the ice-plains of the Polar seas; *Dr. Kane.*—On Molybdenite and Zircon from near Reading, Pa., and on the occurrence of Gold in Pennsylvania; *C. M. Wetherill.*


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THE BANKER'S MAGAZINE,

J. SMITH HOMANS, Editor and Publisher.

THE BANKER'S MAGAZINE

CONTAINS IN ADDITION TO ITS OTHER PAPERS, A REPUBLICATION OF THE FOLLOWING

INTERESTING ARTICLES UPON GOLD AND SILVER,

FOR THE USE OF BANK DIRECTORS, BANK OFFICERS, AND OTHERS.

I. Essay on the Production of Gold and Silver; and its Fluctuations. By Baron Alexander von Humboldt. Translated for the *Banker's Magazine*, from the "*Journal des Economistes*." (*This is the last contribution by the eminent author upon the subject of the Precious Metals.*)

II. On the Distribution of Gold Ore over the Earth's Surface, and on the Structure of California, as compared with that of the Ural Mountains. By Sir Roderick I. Murchison.

III. Anticipations of California,—Effects on the Fixed Price of Gold.

IV. Essay on Money, Coins, Bullion, &c. By J. R. McCulloch, Esq., with Copious Tables of the Gold and Silver Coins of all Nations; their Value, Weight, Fineness, &c., from the Earliest Periods to 1850.

V. The Cost and Production of the Precious Metals.—1. The Cost of the Precious Metals. 2. Cost of Production. 3. Uses of Gold. 4. Annual Consumption of Gold and Silver. 5. Standard of the Currency. 6. Prices of Labor, &c. (*Edinburgh Review.*)

VI. The Relative Value of Gold and Silver.—1. Production of Gold and Silver, 1840, 1848, 1850. 2. Supplies from Russia. 3. Gold and Silver both Legal Tender in France. 4. Permanent Change in Relative Values probable. (*London Economist.*)

VII. New Varieties of Gold and Silver Coins, Counterfeit Coins; with Mint Values. By J. R. Eckfeldt and W. E. Du Bois, Assayers of the United States Mint. 63 *Engravings of Recent Coins of the United States and South America.*

VIII. The Supply and Consumption of Gold and Silver,—Past, Present, and Prospective. (*London Economist.*)

IX. The Future Supply of Gold. (*London Times.*)

X. The Natural Formation of Gold. (*London Athenæum.*)

XI. Coins, Coinage, &c. in Great Britain.—1. Gold and Silver Substitutes for Barter. 2. Account of the Early Goldsmiths of England, and their Mode of transacting Business. 3. Account of the Goldsmiths of Scotland. 4. Origin of Gold and Silver Coins in England. 5. Attempts of the Government to issue Spurious Coin. By W. J. Lawson, Esq.

XII. Curious Facts relating to Gold. (*London Banker's Magazine.*)

XIII. Gold and Silver,—their Supply, Production, and Relative Values. German Quar. Mag., *Deutsche Vierteljahrs Schrift*, *Erstes Heft*, 1852.

XIV. The Prospective Value of Gold.—1. Cost of Production. 2. Effects of a Larger Supply. 3. Who are the Chief Sufferers by a Depreciation in the Value of Gold?

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The next No. of this Journal will be published on the first of May.

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VOL. XV. MAY, 1853. No. 45.

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WITH TWO PLATES.

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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. XXXII.—*On the Electrotyping Operations of the U. S. Coast Survey;* by George Mathiot, Electrotypist: being a Report to Major I. I. Stevens, Assistant in charge of the Coast Survey Office.* With a Plate.

In compliance with your request, I present the following report of the electrotype art as now practised in this office. Most of the apparatus and processes here used are entirely new.

To clearly exhibit the advantages derived from their introduction, it will be necessary to consider the scientific principles involved in their use, and also to take a cursory view of the history of the electrotyping art.

The art of working metals by electric currents is of very recent introduction; and although it has advanced with great rapidity, it is yet, perhaps, in a state of infancy in its applications, and of crudeness in the modes of conducting it.

The electro-deposition of metals was observed by most experimenters with the voltaic battery. As early as 1804 electro-gilding had been successfully practised; but the idea of making castings by electric currents does not seem to have occurred to any one previous to the introduction of Daniel's battery, to which electro-casting is incidental.

After the introduction of Daniel's battery, it simultaneously occurred to several persons that electric currents might be used

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* Dated Electrotype Laboratory, Coast Survey Office, Washington, November 29, 1851, and published as Appendix 55 to Senate Document, No. 3.

to make castings of a finer kind than were obtained by melting and pouring. Propositions to this effect are about all that can be attributed to the rival claimants for the invention of electro-metallurgy; for neither the English nor Russian philosopher revealed what had not been known before.

Yet to Jacobi and Spencer is due the merit of having called public attention to the subject; for in doing this, they have conferred benefits on the world greater, perhaps, than by making an original discovery.

After the publications of Jacobi and of Spencer had called the attention of the scientific world to the new art, the principles involved in it became the study of several eminent philosophers, who disclosed the methods to be followed for obtaining reguline metal. After this, several departments of electro-metallurgy rapidly advanced. Electro-plating, and the multiplication of pages of letter-press work, as pages of type, and wood-cuts, (electro-stereotyping,) were soon extensively practised; but the copying of the delicate touches of the copper-plate engraver (the electrotype proper) was beset with difficulties. On account of the great value of the engraved plate, together with the risk of its being detroyed in the attempt to copy it, and the uncertainty as to whether the duplicate would have good metallic properties, even if the operator should have the good fortune to obtain one, this department of the art, (the first and most beautiful of Spencer's suggestions,) was allowed to rest as an experiment or be confined to articles of small size and value.

Adhesion of deposite to matrix.—Electro-metallurgy requires that the deposited metal should have all its cohesive properties. If such a deposit of copper is made on a clean plate of copper, it is obvious that the deposited metal will cohere with the plate on which it is made, and an elaborately engraved plate would thus be converted into a mere mass of metal. The electrotype art, therefore, cannot exist before means are provided for preventing this destructive adhesion.

Various plans for overcoming this difficulty have been proposed. All these, however, have a common feature, which is to prevent the deposit and matrix from touching by means of an intervening film of heterogeneous matter.

Mr. Smee proposes to use that coating of air which adheres so firmly to polished metals, (so strikingly exhibited when the attempt is made to wet a polished knife-blade.) To obtain the air coating, he directs that, after every attachment has been made to the plate, it be placed in a cool and moist cellar for a few days before introducing it into the electrotype vat.

Smoke, black lead, oils, and powders, and wax, have also been proposed for covering the face of the plate.

The method used in the British ordnance survey is perhaps the best of all these. This is conducted as follows: The plate is first well oiled, and the oil well wiped away with soft bread. The plate is then heated to above the temperature of melting wax, and a cake of white wax pressed against the edge. The oil having removed the air from the plate, the wax will flash over it in an extremely thin sheet or film. All excess of wax is then to be wiped away with a fine linen cloth, free from lint. The plate must be left to cool before introducing it into the vat.

To smear the face of the finely engraved plate is in opposition to the fundamental idea of the electrotype, which is that of atomic casting. In the process of Mr. Smee, air bubbles will be retained in the fine lines of the graving, thus mutilating the copy; moreover, the face of the new plate is waved from the agitation of the stratum of air when receiving the first portion of copper.

In the waxing process it is almost impossible to free every line from excess of wax. Even days of tedious application do not insure perfection. In addition to the coarseness of these various methods, they are extremely uncertain as to whether they effect the purpose for which they are applied.

It was always observed that if the deposited metal was *not deficient* in mechanical properties, it stuck very hard to the original, and the plates had to be subjected to violent jarring, heating and beating, to separate them. But if the deposited metal was of very fine quality, then most likely the deposit was *inseparably* united to it. From these circumstances attending the adhesion of the deposit, it occurred to me that, when the cohesive force was but feebly developed in the deposited metal, then the force of cohesion or homogeneous attraction could not extend the distance presented by the thickness of the film of heterogeneous matter between the plates; but that when these forces were well developed, the spheres of homogeneous attraction of each plate would extend through the wax or air film.

It may be proper here to remark that the above views of adhesion have been applied to another department of electro-metallurgy with the most gratifying success. In electro-plating the difficulty of obtaining a firm adhesion of the film of precious metal is entirely obviated by making such arrangements as insure a rapid deposition of highly ductile metal at the moment the article to be plated is immersed in the electrolyte.

In considering the sticking of the plates, after homogeneous attraction or cohesion, heterogeneous attraction or adhesion demands attention; for two similar bodies may be separated by a film of heterogeneous matter, which binds them more firmly together than their particles are held together by cohesion, as we see in the use of cements.

This force is very powerful between some bodies, while between others it is very slight. Air adheres very strongly to metals, as before referred to; hence a film of air may unite two copper plates, even though they are separated beyond the distance at which cohesive attraction takes place.

Wax is a common ingredient in cements; its adhesive properties have become proverbial; its use is evidently improper. Therefore a substance having a strong adhesive attraction for the plates must not be on the face, and the cohesive force of the surface particles must be suspended by other methods than making the deposited metal deficient in mechanical properties.

It was hoped that a substance could be found that would act uniformly and gently on the surface of the engraved plate, and which in destroying the homogeneous attraction of the surface particles, would, by chemical union with them, form an insoluble and friable compound, having but a slight adhesion to the plate. I was led to select iodine for the experiment on account of its sparing solubility in water, its high equivalent number, and innoxious qualities. A copper plate was well cleaned, exposed to the vapor of iodine, and electrotyped; the deposit separated from it readily. This was repeated some hundred times with invariable success.

It was found, in cleaning large plates for the application of the iodine vapor, that while one part of the plate was being cleaned, another part would tarnish, and hence a uniform action of the iodine could not be obtained. This led to silvering the plates before iodizing, which facilitated the cleaning and exhibited the action of the halogen. A silvered plate was washed with an alcoholic solution of iodine and electrotyped; the electrotype separated from the matrix yet more readily than before, the iodid of silver serving better to prevent adhesion than the iodid of copper.

But it was soon observed that a plate prepared on a dull day did not separate so readily as one prepared under a bright sky, and on experimenting it was found that a plate iodized and exposed to sunshine would separate with very great facility; while a plate iodized on a rainy day, and placed in a dark room for a few hours before introducing it into the vat, might stick so hard as to require some of the old resorts of heating and jarring to separate it from the matrix.

The process of iodizing and exposing to light has now been applied to a very great extent of finely engraved surface, and in no case has the least difficulty been found in lifting one plate off the other when the requisite thickness had been obtained.

I am aware that it may be thought that the iodine acts only by intervening between the plates; but the quantity of iodine applied to a plate must be thought insufficient to effect it by mere mechanical separation when we consider the large quantity of silex and carbon found in ordinary copper. If but one ounce of copper be dissolved from a square foot of ordinary plate, a very heavy deposit of impurities is left, (sometimes 5 per cent.) and the quantity of wax which may be applied to a plate, and fail to prevent sticking, is ten thousand times more than the quantity of iodine which prevents it.

In preparing our largest plates, having ten square feet of face, I use a solution of one grain of iodine in twenty thousand grains of strong alcohol. If one grain of the solution is required to wet a square foot, it will give but $\frac{1}{20000}$th of a grain of iodine on a square foot. But as the iodine evaporates rapidly with the alcohol, probably the actual quantity on a square foot does not exceed one-hundred-thousandth part of a grain.

Taking the weight of a cubic inch of iodine at 1,250 grains, and supposing that it remains on the silver surface in its elementary state, instead of forming iodid of silver, then we have $1,250 \times 144 \times 100,000 = 18,000,000,000$, only one-eighteen-thousand-millionth part of an inch for the thickness of the coating of iodine. Even if we suppose that the solar rays decompose the iodid of silver, and leave the iodine in vapor on the plate, it will still be only one-forty-four-millionth part of an inch—a thickness to be taken as nothing in a mechanical view.

To test the effect of the chemical method of preventing adhesion on the sharpness of the engraved lines, an engraving was seven times successively transferred from plate to plate, when the closest inspection failed to show any inferiority of impressions from the last plate as compared with those from the first.

Time and expense of electro-casting.—Next in importance to securing a certain and easy separation of the matrix and casting is bringing the entire time and expense of electrotyping within the narrowest limits.

Mr. Smee and others have shown that the quality of electro-metal is determined by certain relations between the rapidity of forming the plate and the strength of the solution in which it is formed. Both the common operations of the electro-metallurgist, and the improvements he proposes, must conform to these relations.

As small quantities of electricity are easily set in motion, small-sized electro-castings are readily made in six or eight days. To make large castings in a short time requires a powerful current. To accomplish the corresponding augmentation in the effective electric action has proved a somewhat difficult matter.

At the date of the "Aide Mémoire to the Military Sciences," it is stated that in the ordnance survey one pound of copper was deposited in twenty-four hours on a plate of eight square feet, the plates being made ductile enough to bear hammering only by continued agitation of the electrolytic solutions.

At this rate, to make a plate one-eighth of an inch thick will require forty-five days. So far as I am informed, the above performance has not been excelled, as to quality and time, on large work anywhere prior to its being attained as now to be described.

The first and most obvious suggestion for increasing the rate of deposition is to enlarge the battery; this, however, is incapable of producing the desired end.

To present this subject in a clear and satisfactory manner, I will make use of the celebrated formula of Professor Ohm, who deduced from mathematical reasoning, and established by experiment, that the effective force of the current from any battery was directly as the electromotive force, and inversely as the resistance offered to that force.

To express this, he gave the equation $\frac{E}{R+r}=Q$, in which E represents the electromotive force, or affinity of acid for zinc, and $R+r$ the resistance to the current generated by that force; R representing the resistance offered to it from the liquid contained between the positive and negative elements of the battery, and r the resistance offered by the object on which the battery is working, and Q the amount of work executed, or the quantity of the current obtained.

The resistance of conductors has been found to be directly as the length, and inversely as the section.

So far as concerns form of arrangement, E is constant for the materials used, as it depends on their chemical relations, Q can therefore be favorably affected only by varying R or r. Now, as R represents the resistance of the liquid contained between the battery plates, to increase the size of the plates is only to increase the section of the liquid, or, in other words, to diminish the resistance represented by R. The expression, $\frac{E,}{R+r}=Q$, shows that, if the resistance in the battery is small compared to the external resistance, the gain of effect from enlarging the battery plates is but small.

To determine the relative value of R, as compared with r, a battery was constructed so as to collect and measure the gas evolved by its action.

The plates were placed in contact with each other, and the gas evolved in thirty minutes taken as a unit of effect. As in this case the current did not pass through anything but the battery, there is no resistance to be represented by r, or r in the formula will be equal to 0 and $Q=\frac{E}{R}=1$.

The battery was then attached to a pair of electrodes, in a certain solution of sulphate of copper and sulphuric acid, especially recommended by all the writers on electro-metallurgy, the arrangement being such as to produce good metal. The gas now evolved in thirty minutes was found only one-twentieth of the former amount; hence the introduction of the resistance, r, had diminished Q twenty times, and $\frac{E}{R+r}=Q=\frac{E}{20\,R}$, whence r is equal to 19 R. To exhibit the effect of battery enlargement, we now have $Q=\frac{1}{\frac{1}{m}+19}$. If $m=1$, then $Q=\cdot05$; if $m=2$, $Q=\cdot0512$; if $m=3$, $Q=\cdot0518$; if $m=4$, $Q=\cdot0524$, &c., &c. This shows a gain of only a fortieth from doubling the size of the battery, &c.—an advantage too small to repay for the enlargement. These calculations are in accordance with experimental results from small batteries, but in large ones the necessity of further separating the plates, in increasing their size, makes the resistance increase, instead of diminish, and there is consequently a loss from enlargement. It is not, therefore, by merely increasing the battery surface that the time for electrotyping can be shortened.

Mr. Smee, the distinguished writer on electro-metallurgy, by covering the negative plate of the battery with pulverulent platinum, produced a very energetic form of the instrument. When the plate is freshly platinized, it acts violently, and throws off the hydrogen in torrents. But this increased energy of the plate is gradually lost, from the electric current depositing upon it impurities from the zinc.

As this deposit has a strong attraction for the hydrogen, it is retained on the plate. The plate, being thus encased in air, is virtually excluded from the liquid of the battery. The ordinary solvents of the metals do not readily remove this coating of impurity. The plate can be renewed by replatinization; but, as this is both tedious and expensive, I was urged to find a menstruum which would restore the original platinum to its energy. This I attained, at length, by immersing the plate in a solution of per-chlorid of iron, which almost immediately restores the action of the plate.

The plates are now daily immersed in the chlorid of iron, by which the tone of the battery is constantly maintained.

By this last discovery, together with obtaining better solutions for the decomposing cell, the time for making a casting was reduced; but still the time required for making a plate was too long when only one electrical equivalent was employed.

The effective force of one battery may be added to another. This is increasing E in the formula, and this will sometimes increase Q.

We unite the effective force of many batteries by joining their dissimilar ends in consecutive order. As the current in such an arrangement has to traverse every battery in the chain, R will be multiplied as many times as we multiply E. The formula then becomes $Q = \frac{n\,E}{n\,R + r}$. When the value of r and R are nearly equal, and we have batteries of definite construction to work with, it becomes a matter of some importance to determine whether we shall use the whole galvanic apparatus, as a single electrical equivalent, by connecting all the similar parts of all the battery cells, or whether we shall convert it into a battery of two pairs, in consecutive order, by joining dissimilar ends. As dividing the battery is doubling R, and to double the electrical equivalents is also to double R, we shall increase R fourfold by the double arrangement. Instead of $Q = \frac{E}{R+r}$ we have $Q = \frac{2\,E}{4\,R + r}$. Taking $R = r$ we have $Q = \cdot 50$ in the single arrangement, and $Q = \cdot 40$ in the double—showing that we may double the expense, and yet make the casting more slowly than before. Conditions as above are of frequent occurrence, and a knowledge of them without experimenting is of very great importance.

For $R = 10\,r$, with a single equivalent of battery, $Q = \frac{1}{1+10} = 0{\cdot}0909$. For two batteries in series $Q = \frac{2}{2+10} = 0{\cdot}166$. The use of two batteries in consecutive order, as thus exhibited, doubles the expense, but does not double the effect. A regard for economy prohibits us from further increasing the series. To represent an effect double of $\frac{E}{R+r}$ we have $2\left(\frac{E}{R+r}\right) = \frac{2\,E}{\frac{2\,R + r}{2}}$. As dividing R by 2 is doubling the battery surface, we may now make $Q = \cdot 183$. The gain per cent., now indicated by doubling the surface, makes it advantageous to make this increase when two consecutive batteries are used.

The difficulty of obtaining large flat plates of silver proved a serious obstacle in effecting an increase of battery surface, for the irregularity of the surface requires the plate to be placed at an increased distance from the zinc, thereby augmenting R, the very thing sought to be diminished.

Plates could be made flat by the planishing hammer; but the operation being expensive, and the plates continually liable to accidents in use, economy prohibited this mode of forming flat plates. Though the plating of metallic bodies with silver had been well executed, it had not yet been determined that electro-casting of silver could be executed in a desirable manner, and at a moderate expense and trouble. At first, every attempt to make plates weighing 2,500 grains to the square foot failed, on account of the impossibility of observing Mr. Smee's laws of electro-metallization for the time required.

But after modifying the solutions of silver, and using a register battery, a plate could be made in thirty hours, perfectly flat, and possessing the mechanical qualities of hardness, elasticity, and malleability, in an eminent degree, and not costing over 16 cents per ounce for the making.

The perfectly flat plates admit of a very close approximation to the zincs. Their size may therefore be increased to more than twice their former surface, as in the double arrangement, r is relatively smaller to R.

Important changes have also been made in the modes of operating, and in the arrangement of the apparatus. It had early been noticed that changes of temperature influenced the rate of working; and every electro-metallurgist knows the importance of keeping the laboratory warm.

To determine where and how the effect of temperature took place, a battery, at 60 degrees Fahrenheit, was connected with a wire 120 feet long, and enclosing a galvanometer. The deflection was 40 degrees; the battery was then cooled until the temperature was 48°; the needle was still deflected nearly 40 degrees.

This experiment indicated that the batteries were not greatly affected by ordinary variations of temperature. Advantage was then taken of this development to secure a more perfect ventilation. Accordingly, a small room, to contain the battery, was partitioned off from the general apartment by a glass partition, and large outward openings made at the top and at the bottom of the room, to give a circulation of air for carrying off the battery fumes.

At the stage of improvement now described, one of our medium plates, having eight square feet of surface, could be readily made in from eight to ten days. But wishing still further to quicken the process, or attain my first desire—to deposit one pound per day on the square foot, with a single equivalent of battery—improvements were again sought after. As the E of the formula has been increased to the greatest extent the cost would permit, and R had been diminished, or the plates increased in size to the greatest useful extent, it was sought to increase Q by diminishing r, or the electrolytic resistance. It was sought to increase the conducting power of the electrolyte by adding easily decomposable salts to it; but with no success. The accelerating effect of temperature being found, as above stated, to be confined chiefly to the decomposition cell, it was evident that by using the electrolyte alone, at a high temperature, a considerable advantage might ensue.

To determine the most advantageous working temperature, and the resulting gain of effect, a voltameter battery was connected to a pair of electrodes, in the solution formerly described as being generally recommended. Each electrode had five square inches of face, and was coated on the back to prevent radiation. They were placed one inch apart, and had thin plates of wood bound against their edges, to prevent any lateral spread of the current in passing between them. The following was then obtained:

Battery plates in contact			gave	300	cubic inches	gas	per hour.	
Electrodes in contact			do.	216	do.	do.	do.	
Current through electrolyte,	at	58°,	gave	16	cubic in.	gas	per h.	23·15
do.	do.	60°	do.	20	do.		do.	18·15
do.	do.	100°	do.	27	do.		do.	13·00
do.	do.	175°	do.	37	do.		do.	8·96

The last column of figures shows the value of the resistance of the solution, as compared with R of the formula. This column was obtained by first uniting the battery plates, and afterwards the electrodes.

From the above table it appears that heat may be made to diminish the resistance in the decomposition cell in the proportion of 2·58 to 1; and the whole resistance by 2·25. And as $\frac{2 \cdot E}{R+r} = \frac{E}{\frac{R+r}{2}}$; therefore, by heating the electrolyte, we may with a single electrical equivalent make a plate as rapidly as by working at atmospheric temperatures with two batteries in consecutive order, with double surfaces, (four times the battery and twice the expense.)

But as Smee's laws require that, in forming a plate, certain mutual conditions of apparatus be maintained, it follows that alterations in one element or condition must be attended by corresponding changes in the others. Hence, if the temperature of the electrolyte be raised to a certain point, and the apparatus correspondingly adjusted, it is evident that, to avoid incessant adjustment, the original temperature must be maintained.

Thus, to avail ourselves of the advantages experimentally found from heating the solutions, an apparatus for steadily maintaining a high temperature in the electrolyte through several successive days becomes indispensable.

As the electrotype operations are not suspended at night, it is important that the heating apparatus should perform its office for at least twelve hours without supervision or replenishing its fuel; and its action should be sensibly uniform, during all the time, between successive replenishings.

Such an apparatus I have devised, and is now in use. A peck of charcoal furnishes fuel for twelve hours, and maintains 100 gallons of copper solutions steadily, at any required point between 100° and 200°.

With the above arrangement in use, I have made a large reverse or alto, and returned the original to the engraving department in 55 hours from its being placed in my hands. This time included trimming the edges and the preparations to prevent adhesion.

Again recurring to Ohm's formula, the relative value of R to r was once more experimentally found. This gave $R : r :: 1 : 4$ or $Q=\frac{1}{1+4}=0{\cdot}20$, a great improvement as compared with the first determination of $R : r :: 1 : 19$, or $Q\frac{1}{1+19}=0{\cdot}05$. Having now made r so small compared with R, the size of the battery can be profitably increased until the result is about 0·24. Moreover, using a double arrangement of cells with double surfaces, for a double effect, we now have $2\left(\frac{1}{1+4}\right)=\frac{2}{2+4}=0{\cdot}40$. As the relative resistance of the electrolyte becomes now still smaller, we may yet more increase the battery surface until the result is nearly 0·5.

The electrotype has now ceased to be a mere experiment, uncertain, expensive, and slow. I have lately formed plates of most excellent quality, at the rate of three pounds to the square foot, in 24 hours. This rate will require but two days to form one of our largest plates, having ten square feet surface, and one-eighth of an inch thick.

Actions in the electrolytic solution.—The quality of the deposited metal is governed solely by the relations between the *quantity* of the electricity passing through any solution and the amount of metal the solution contains. The usual supposition is, that the acid of the salt goes to one electrode and the metal to the other, but it is now ascertained that no such mutual transfer takes place; for, while the acid is carried to the positive electrode, the metal is *not* carried to the negative electrode. Hence, however strong the solution on commencing the process, the negative electrode, by abstracting the metal in its vicinity, is soon surrounded with a weak solution. With a simple wire electrode, the exhausted solution surrounding the electrode is readily renewed by mere difference of specific gravity producing a flow. But, with large parallel plate electrodes, this rapid renewal of dense solution becomes impossible, and the electrode is soon surrounded with a weak solution. This state of things must be recognized in adjusting our battery arrangements. Electrotypists not aware of this fact find themselves much perplexed by failing to accomplish with large plates what is so easily done with medals or small plates.

It would, at first sight, appear that, by strengthening the solution of sulphate of copper, a more rapid supply of metal to the electrode would be obtained. Unfortunately, the effect of this is to diminish the solvent capacity of the water in the solution for the sulphate formed on the positive electrode by the action of the transferred acid. The grand essential in electrolysis is liquidity. Thus, if the quantity of free water surrounding the positive electrode be small, this electrode is soon enveloped in a saturated solution, and the newly-formed salt remains undissolved upon it. This salt, being a non-conductor, virtually excludes the electrode from the solution, and thus arrests the current, except when the efflux of saturated solution permits the salt to dissolve, and so reopens the passage for the current in irregular quantities. From this spasmodic action result plates of copper-sand, or sometimes copper as soft as lead.

By applying heat to the solution when this state of things exists, the solvent capacity of the water for the salt is increased, rapid diffusion takes place, the salt is carried to the negative electrode, and the exhausted water to the positive electrode; the dormant batteries rush into uninterrupted action, and in a short time a plate is deposited, having all the hardness and elasticity of hammered or rolled copper. Smee's conditions, then, seem to maintain themselves. The electrotypist's axiom of "work slowly," requires to be reversed into "the quicker the work, the better the quality."

Laboratory apparatus.—Figure 1 is a plan of the coast survey electrotype laboratory. The glazed partition, *b, b, b, b*, with a door, *d*, separates the battery room from the general laboratory, and permits an easy inspection of the batteries, without exposure to their fumes. The laboratory floor is about six feet above the ground, and slopes inward from the sides towards the scuttle holes, *h, h, h, h*, arranged for discharging the waste liquids spilled upon the floor. To obviate the deleterious effects of working on a floor saturated with chemical agents, when any solutions are spilled, the floor is well flooded and brushed, the water passing off through the scuttle holes. There are four battery cells, placed as indicated, B, B, B, B. A rectangular India-rubber bag, supported by a deep wooden box, contains the battery solutions. Each cell can contain nine silver and eight zinc plates. A metallic connection unites all the zinc plates of a cell, and another one all the silver plates. Each cell can be used as an independent battery, or two, three, or four cells can be connected in consecutive or simultaneous order, or all combined into two pairs of two in consecutive or simultaneous order, or into one group of three and one of one. The position of the vertical decomposing vat is shown at V, and that of the horizontal vat at H. S is a large tub for washing plates. The tub C contains the solution of chlorid of iron. Q is the quicksilver tub, and W, W, are fresh water tubs. F is the furnace, and *d*, *d*, *c*, *c*, are heating tubes connecting with the vat H. T is a flat iron table.

Fig. 2 exhibits a cell and its included plates, with their mode of suspension.

Fig. 3 represents the suspending frame of wood and the attached plate, P, prepared for immersion in the vertical vat.

Fig. 4 shows the vertical vat and the plates suspended in it.

Fig. 5 represents the adjustable plate-supporting frame used in the horizontal vat.

Fig. 6 exhibits the interior arrangement of the horizontal vat, a blank plate and an engraved original being in position; also the connecting copper rods leading to the battery.

Fig. 7 represents the heating furnace. The door for admitting air is shown at *a*, and is so connected with an adjusting compound bar of iron and zinc that by an adjusting screw it can be arranged to regulate the draught, opening or closing the door, thus maintaining a uniform heat in the solution. After getting the fire started, this door is set so as to close when the solution reaches a heat of 180°. In principle this furnace is similar to a bath-heater. A tubular helix of lead is coiled within it like the worm of a still, and the terminating branches *c* and *d* lead to the horizontal vat, the branch *c* uniting the top of the vat just below the liquid surface with the top of the coil, and *d* at the bottom of the vat with the bottom of the coil. Hence follows a circulation of the solution from the furnace at top and into it at bottom.

Manipulation.—When a plate is to be electrotyped, it is placed on trestles above the open scuttle holes, *h*, *h*, *h*, *h*, and thoroughly cleaned by washing with alkalies and acids. It is then silvered, iodized, and placed before a window. A plate of rolled copper an inch larger than the engraved plate is then selected, placed on the flat iron table, and beaten with mallets until a steel straight edge shows it to be plane. It is then weighed and fixed in the vertical plate frame by two copper hooks. The engraved plate is then similarly fixed in a similar frame, when both are placed in a vertical vat and connected with the battery.

The process does not go on well when the plates are vertical, but it is necessary to start the castings in this position to prevent dust, motes, or specks of impurities, from settling on the face. As the rolled plate dissolves, its impurities rapidly render the solution muddy, and endanger the face of the forming plate. For common electrotypes dust or mote specks are not detrimental; but the coast survey copper plates being not inferior in fineness of lines to fine steel plates, the effect of impurities settling on the face of their copies is to give the impressions a clouded appearance. On first immersing the plate, the solution should, therefore be perfectly clean. Formerly, after each use of the vertical vat, it was emptied and washed out. When the solution had deposited its sediment it was drawn off and strained through very fine cotton. This whole operation was extremely disagreeable, and consumed a whole day of one man.

By a simple expedient I have saved the necessity of cleaning the vat oftener than once a month. To guard the new plate from specks and impurities, a bag of fine cotton is drawn over a slight wooden frame, which keeps it distended. An hour or more before the solution is wanted, the bag, with its included frame, is placed on top of the solution and loaded with the copper bars used to support the plate frames. The weight causes the bag to sink gradually, filtering the contained solution as it goes down; the impurities cannot wholly choke the meshes of the cloth, as a fresh portion is constantly brought into action during the sinking. I thus filter the solution without taking it from the vat or disturbing the sediment, saving much labor, time, and annoyance.

The plate remains in the vertical vat over night, and preparations are made in the morning to transfer it to the horizontal vat. The furnace is first brought into action. A new plate of blank copper, an inch larger than the matrix, is flattened on the iron table, and bolted to the edges of wooden bars by platinum bolts, for the purpose of preventing the plate from sagging downwards when supported horizontally. The plate so arranged is called the strapped plate. The coated matrix is then taken from the vertical vat, disengaged from its frame, and arranged in the horizontal frame. A wooden wall, an inch high, then surrounds the plate, and on this wall the strapped plate is laid, when the whole combination is placed in the horizontal vat and the connection with the battery established. The positive plate is then taken from the vertical vat and its loss of weight noted and recorded. From the known superficial area of the matrix, the quantity of copper required for a casting one-eighth of an inch thick is computed and recorded. The blank copper consumed in both vats must equal this amount before the required thickness is reached, allowance being made for impurities of rolled copper and roughness on the back of the electrotype. After a few hours of action the strapped plate bcomes so loaded with impurities that they will begin to drop on the electrotype; this plate must, therefore, be removed from the vat and a new one immediately supplied. The dirty plate is then washed in the large water tub, and when cleaned its loss of weight is found and recorded. By the amount of loss the action of the batteries is tested, and it is found, if Smee's laws are being observed. Vigilance must now be exercised in watching the batteries and rate of work, and the power must be varied to suit circumstances.

The entire working battery generally requires renewal once a day, the process being conducted as follows: One zinc and one silver plate are taken from the battery; the silver placed in the solution of chlorid of iron, and the zinc taken to the water tub outside the door of the battery room, where it is scrubbed clean with a hard brush. It is then re-amalgamated at the quicksilver tub, and taken back to the battery. The silver plate is transferred from the chlorid of iron solution to the adjacent fresh water tub. Another plate is then transferred from the battery to the chlorid solution, and another zinc cleaned, washed, and put back in the battery with the first silver. In this manner the whole battery can be renewed without sensibly interrupting its action.

When the loss of weight from the rolled copper in both vats indicates that the required thickness of the electrotype is gained, the plate is withdrawn from the battery, detached from its frame, its back smoothed, and its edges filed, until a separation can be made. By separation, the original becomes liberated, and the alto or reversed relief is silvered and electrotyped exactly as an original. The copy from it, or the electrotyped basso, will, if the process has been properly conducted, be a perfect fac-simile of the original, and in hardness, ductility, and elasticity, will equal the best rolled and hammered or planished copper plate.

ART. XXXIII.—*Brief Characters of some New Genera and Species of Nyctaginaceæ, principally collected in Texas and New Mexico*, by CHARLES WRIGHT, Esq., under the direction of Col. J. D. GRAHAM, U. S. Topogr. Engineers, late Chief of the Scientific Corps of the Mexican Boundary Commission; by ASA GRAY, M.D.

(Concluded from p. 263.)

ABRONIA, Juss.

ABRONIA (TRIPTEROCALYX) CYCLOPTERA.—Abronia (Tripterocalyx) micranthum, *Torr. in Frem. 1st Rep. p.* 96, *& in Emory, Rep. p.* 149. Cycloptera annua, & Apaloptera annua, *Nutt. in herb. Hook.*—The excellent specimens gathered by Mr. Wright on the Rio Grande, New Mexico, plainly show Dr. Torrey's A. micrantha was founded on the precociously fertilized state of a species, the fully developed flowers of which are the very largest of the genus. I will not hesitate, in this case, to change the specific name. In the appendix to *Stansbury's Exploration of the Valley of the Great Salt Lake*, p. 395, Dr. Torrey suggests that the plant in question may be only a small-flowered state of Abronia mellifera. The Abronia mellifera of Douglass, however, is a manifestly different species, the fruit of which is winged, indeed, and more strongly than in any other genuine Abronia,—so much so as to forbid the separation of Tripterocalyx as any thing more than a subgenus,—but the wings are triangular, pointed, and entirely lateral, not meeting over the summit of the fruit. Its flowers too are greenish, while those of A. cycloptera are light purple. Furthermore, what Dr. Torrey takes for the Abronia mellifera is the A. fragrans, *Nutt. in herb. Hook.*, which is distinguished, probably specifically, by its very large and broad, scarious or petaloid leaves of the involucre, and its white, or "porcelain-colored" flowers. The *monocotyledonous embryo*, first noticed by Dr. Torrey in his A. micrantha, he has since shown to exist throughout the genus; the inner cotyledon being constantly wanting. Dr. Torrey's observation appears to have escaped Prof. Choisy's notice. In Emory's Report, Dr. Torrey has further corrected the character of the genus, especially noticing the adhesion of the filaments to the tube of the perigonium, and the two-cleft lobes of the limb of the latter, which are not "deciduous," but involute after anthesis.

QUAMOCLIDION, Chois.

1. **Quamoclidion oxybaphoides** (sp. nov.): caulibus procumbenti-diffusis gracilibus; foliis omnibus profunde cordatis longiuscule petiolatis, infimis reniformibus, superioribus acuminatis nunc subangulatis; involucro trifloro profunde 5-fido cum pedunculis laxe paniculatis glanduloso-viscosissimo, lobis ovatis acutiusculis perigonio campanulato paullo brevioribus; staminibus 3; fructu subgloboso-obovoideo.—At the foot of mountains east of El Paso, in the shade of high rocks (*Wright*, No. 596): also in mountain ravines of the Chiricahui Mountains, at Guadalupe Pass (*Wright*, No. 1721 in part); Sept., Oct. In habit and foliage this plant resembles Choisy's Quamoclidion nyctagineum, except that it is more slender, and smaller in all its parts, and the leaves (from one to two inches in length and breadth) all have a reniform-cordate base. The involucre is very similar, except that the lobes are not acuminate, and scarcely acute; they are only 3 lines long; those of Q. nyctagineum, said by Choisy to be 3 lines in length, are twice that length in my original specimen. The few flowers seen of the present plant show a campanulate perigonium, barely four lines long, with no tube, except the globular base, and only three stamens. The fruit is smooth, destitute of ribs or angles, glabrous, blackish, and very obscurely rugulose-reticulated under a lens. Our plant is probably a congener of Choisy's Q.? angulatum (if what was represented as a multiple stigma in Moçino and Sesse's drawing be no more than the coarsely granulated simple stigma of this and other species), and perhaps closely related to it; but the stamens are only three, and apparently not "long exserted." Their number and the form and size of the perigonium would refer the species to Oxyba-

phus; but I rely rather on the strongly five-ribbed fruit, with the at length dilated and scarious involucre, to distinguish that genus. Quamoclidion, strengthened by this and the following species, it seems most convenient to retain as a genus, although it differs from Mirabilis only as the first section of Oxybaphus differs from the second. While the form of the perigonium of the present species is as in Oxybaphus, that of the following resembles that of Mirabilis.

2. Quamoclidion multiflorum (Torr. ined.): caulibus suberectis; foliis breviuscule petiolatis subcordatis acutis; involucro magno glabro campanulato 5-fido 4–8-floro; perigonio infundibuliformi, limbo expanso; staminibus 4–5. Oxybaphus multiflorus, *Torr. in Ann. Lyc. N. Y.*, 2, *p.* 237. Nyctaginia? Torreyana, *Chois. in DC. Prodr.* 13, *p.* 430. Stony hills near the copper mines of Santa Rita, New Mexico (*Wright*, No. 1703). To this belongs No. 1327 of Coulter's Mexican collection; No. 559 of his Californian collection; No. 85 of the collection of Wislizenus, &c. The involucre is an inch in length; and the full-grown perigonium fully two inches long. In the original description, Dr. Torrey plainly stated that the involucre is "quinquefid," and therefore gamophyllous.

BOERHAVIA, Linn.

§ 1. Fructus 5-angulatus vel 5-costatus, obpyramidatus vel obovatus.

1. Boerhavia purpurascens (sp. nov.): caulibus e radice annua adscendentibus laxe ramosis; ramis glanduloso-viscosissimis; foliis caulinis ovalibus oblongisve utrinque obtusis subtus pallidioribus sæpeque purpureo tinctis glabris, ramealibus lanceolatis linearibusve parvis glandulosis; pedunculis paniculatis glomerulum capituliformem 5–8-florum gerentibus; bracteolis 3 oblongis hirsuto-viscososissimis cuspidatis perigonium campanulatum fructumque adæquantibus; staminibus 3; fructu brevissime pedicellato obovato utrinque obtuso lævi, costis angustis validis.—Stony hills near the copper mines of Santa Rita, New Mexico, Aug. (*Wright*, No. 1725). Plant a span to a foot high. Leaves 6 to 18 lines long, very unequal. Rhachis of the glomerule not elongated with age, only two lines long after the fruit has fallen; the persistent pedicels therefore approximate, less than a line in length, the apex more cup-shaped than usual. Bracts tinged with purple, very viscous, enveloping the fruit, at length deciduous; of these the broader one is the true bract, although borne on the pedicel above its middle; the two lateral are the proper bractlets. Perigonium purple, a line and a half long, without any constricted tube. Fruit a line and a half long, perfectly smooth and glabrous, not at all corrugated, with 5 rather distant

and narrow salient ribs.—The following appears to be more nearly related to this than to any other; but it is probably a distinct species.

2. Boerhavia Wrightii (sp. nov.): caulibus e radice annua erectis gracilibus laxe ramosis ramisque glanduloso-viscosis; foliis oblongis undulatis nigro-punctatis subtus albidis, summis linearibus; pedunculis paniculatis spiculam brevem demum sparsifloram gerentibus; pedicellis brevissimis basi unibracteatis apice bibracteolatis; bracteis bracteolisque ovatis cuspidato-acuminatis ciliatis flore evoluto brevioribus; staminibus 3–4; fructu breviter obovato glabro inter costas 5 crassas ruguloso. Pebbly hills near El Paso, Sept. (*Wright*, No. 610). Near Messillas, Northern Mexico, *Gregg* (No. 533, scarcely in flower)? Plant about a foot high. Leaves thickish, small. Rhachis of the slender, interrupted, and mostly simple spikes an inch or more in length. Bract and bractlets purplish, deciduous. Perigonium smaller than in the preceding species, pale. Fruit barely a line in length.

3. Boerhavia linearifolia (sp. nov.): caulibus e radice lignescente diffusis paniculato-ramosissimis glanduloso-viscosis basi hispidis seu villosis; foliis linearibus et lanceolatis brevissime petiolatis mucronato-acutatis crassiusculis margine revolutis parce hispidis; floribus effuse cymosis breviter pedicellatis singulis basi 3–5-bracteolatis; bracteolis persistentibus; staminibus 5; fructu clavato-oblongo glabro utrinque obtusissimo, costis incrassatis.—Var. β. *glabrata:* caulibus inferne foliisque glabris vel glabratis.—Western Texas, common, *Wright*, (No. 608, 1724,) *Lindheimer*. Saltillo, Mexico, *Gregg*. Plant diffusely many-stemmed, forming large bunches. Perigonium purple; the limb rotate when fully expanded, and half an inch in diameter: constricted tube scarcely any. Fruit a line and a half long.

§ 2. Fructus 10-costatus, turbinatus. Perigonium hypocraterimorphum, tubo subelongato villosissimo. Flores glomerulati ad nodos ramorum paniculæ.

4. Boerhavia eriosolena (sp. nov.): glabra; caule erecto hinc inde glutinoso superne ramisque floridis nudis; foliis carnosis ovatis nunc subcordatis margine denticulato-glandulosis junioribus subtus petiolisque parce hirtellis, superioribus in bracteas subulatas parvas transeuntibus; pedicellis brevibus seu brevissimis; bracteolis 4–5 scariosis oblongis cuspidato-acuminatis sub flore verticillatis involucellum efficientibus persistentibus fructu turbinato crasse 10-costato glabro apice truncato paullo brevioribus; perigonio limbo roseo; staminibus 5.—Valley near Azufrora, in Cohahuila or Durango, Northern Mexico, *Dr. Gregg* (No. 512). Plant 3 feet high; the root not seen; the stem rather stout, angled above. Pedicels one or two lines long, three or four together

at each node of the elongated branches of the cymosely paniculate, ample inflorescence, forming a fascicle, which at length is frequently evolute into a proliferous branch. Tube of the perigonium a line and a half long above the abruptly enlarged fructiferous portion, very villous with long and spreading or implexed hairs; the limb 4 or 5 lines wide when fully expanded. Fruit (immature) two lines long.

§ 3. Fructus leviter 10-costatus, elongato-clavatus, rectus, superne sæpius muricato-glandulosus. Perigonium (majusculum) cyathiforme vel infundibuliforme. Flores umbellati.

5. Boerhavia Grahami (sp. nov.): glabra; caule gracili e radice perenni erecto; foliis cordatis repandis, summis ovatis mucronatis; pedunculis paniculatis seu primariis alaribus solitariis folia multum superantibus; umbella 7–12-flora; perigonii limbo cyathiformi viridi-flavo, tubo (supra basim fructiferam) brevissimo; staminibus 2; fructu lineari-clavato viscoso-puberulo superne parce muricato-glanduloso pedicello æquilongo demum geniculato-deflexo. Rocky hills of the Sonoita, Sonora, *Wright* (No. 1715). Bracts 5 or 6, minute, forming an inconspicuous involucre, deciduous. Pedicels 4 to 6 lines long. Perigonium at most two lines long above the fructiferous base. Stigma peltate, as in the genus generally.—Perhaps too closely related to B. scandens; but the stem appears to be truly upright, and the constricted tube of the perigonium is extremely short. The species is dedicated to Col. J. D. Graham, under whose auspices the specimens were collected. Some of the flowers fructify precociously, as in so many Nyctaginaceæ.

§ 3. (Senkenbergia) Fructus leviter 10-costatus, elongato-clavatus, curvatus, hinc gibbosus, demum geniculato-deflexus. Perigonium infundibuliforme (majusculum). Flores racemosi, unibracteati, ebracteolati. (Tinantia, *Mart. & Gal.*, non *Schweidweiler*. Lindenia, *Mart. & Gal.* olim, non *Hook.* Senkenbergia, *Schauer.*)

6. Boerhavia gibbosa, *Pavon in herb.*—Lindenia gypsophiloides, *Mart. & Gal. in Bull. Acad. Brux.*, 10, *No.* 4, *p.* 17. Tinantia gypsophiloides, *Mart. & Gal.*, *l. c.* 11, *No.* 4, *p.* 30; *Chois. in DC. Prodr.* 13, *p.* 457. Senkenbergia annulata, *Schauer in Linnæa*, 19, p. 711.—Mexico, *Moçino & Sesse*, *Galeotti*, *Coulter* (No. 1434), *Gregg* (No. 515). On the San Felipe and San Pedro Rivers, W. Texas, *Wright* (No. 613, 1714). In the plant which flowered in the Cambridge Botanic Garden during the past summer, many of the blossoms were precociously fertilized in the bud, before it was full-grown; while others, even of the same raceme, expanded their rather handsome, rose-purple perigonium (the limb 4 lines in diameter). The pedicels are

barely a line long, much shorter than they are described by Choisy; while the ripe fruit, in well developed specimens, is 4 or 5 lines long (3 lines, *Choisy*): it is articulated with the apex of the pedicel (as it is in Boerhavia), glabrous, and destitute of glands, but sometimes sparsely verrucose with translucent pimples. As in most Nyctaginaceæ, when soaked in water, the surface becomes covered with a thick, mucilaginous mass, from the bursting of the epidermal cells and the uncoiling of the contained gelatinous threads. Prof. Choisy has remarked that the genus Tinantia is scarcely sufficiently distinguished from Boerhavia by its inflorescence and the singular form of the fruit. I adopt the later name of Senkenbergia for this subgenus, because there is an earlier genus *Tinantia* or *Tinnantia*. The first published specific name "gypsophiloides" is so inappropriate, that I venture, in restoring the plant to Boerhaavia, to adopt the characteristic name given by Pavon in his herbarium.

The other species distributed in Mr. Wright's numbered collections appear to be: B. ERECTA, *Linn.* various forms, all of them apparently with annual roots (No. 609, 1726, 1727, 1728); B. PANICULATA, *Rich.* (No. 611); and B. VISCOSA, *Lag.* (No. 612).

ART. XXXIV.—*On the Discovery of two species of Trichomanes in the State of Alabama, one of which is new;* by ASA GRAY, M.D.

WITH one exception, no Hymenophyllaceous Fern has been supposed to grow within the limits of the United States; nor, when the nature of our climate is considered, would any such Fern be expected to occur, except, perhaps, in Florida. The exceptional case referred to, that of *Hymenophyllum ciliatum* of Swartz, said by Willdenow to come from Pennsylvania, as well as the West Indies, doubtless rests on some mistake. At least, a search through the Willdenovian herbarium did not reveal the existence of any specimen to confirm this habitat; neither is the plant enumerated in the *Catalogus Plantarum Amer. Sept.* (ed. 2) of Muhlenberg, who was Willdenow's chief North American correspondent, nor is it found in the Muhlenbergian herbarium. The only person, so far as I know, who pretends to have seen the plant in this country is Pursh, who, in his *Flora Amer. Sept.*, p. 671, gives the habitat "In shady forests, on the trunks of old trees; Pennsylvania and Virginia, v. v." I fear that this statement cannot be implicitly received, however, since more than one case is known in which this author has extended the range of a species and employed the sign *v. v.* where he had never visited the assigned locality. No specimen of any Hymenophyllum was to be found in the herbarium, chiefly of Virginian and Pennsylvanian plants, which Pursh formed for his patron, Professor Barton, nor in that which he communicated to the late Mr. Lambert, and used in the preparation of his Flora.

However the case may be in respect to that plant, it is no longer to be doubted that this elegant, and for the most part tropical or subtropical, tribe of Ferns has representatives in the United States; and I think it worth while to call immediate attention to so interesting and unexpected a discovery. This discovery was made by my excellent correspondent, Thomas M. Peters, Esq., of Moulton, Alabama, in the northeastern portion of that State. It was in July last that Mr. Peters found, about twenty-five miles south of Moulton, a species of *Trichomanes*, which he determined to be such. In December, the same gentleman, in connexion with J. F. Beaumont, Esq.,* found a second locality near Mountain Home, in the adjacent county of Lawrence (of which Moulton is the Shire town). Mr. Beaumont had sometime before discovered the plant in Franklin county, farther west, and had sent me specimens collected in November. Specimens liberally communicated to me by both these gentlemen so nearly agreed with *Trichomanes radicans* of Swartz,† especially with growing plants brought from Killarney, that I had little hesitation in referring them to that species; and this view was at once confirmed by the high authority of Sir William Hooker, to whom specimens were immediately forwarded. The fronds, however, are all smaller than the ordinary forms of Trichomanes radicans, being from two to barely five inches long; they are also narrower in outline, and less compound, being only bipinnatifid. The specimens from the two localities represent two forms of the species; one form having longer and narrower segments to the frond and long-exserted receptacles; the other is a more condensed form, with the receptacles less prolonged. According to Hooker the species is a very variable one, and most widely diffused, from Jamaica and the other West Indies to Mexico and Brazil, and even to the Sandwich Islands; while in the Old World it is found in Ireland, in the Azores, Madeira, Teneriffe, and even in Nepal.

The plant occurs, in Alabama, on the face of sandstone cliffs that overhang small streams, and particularly on the under surface of overhanging rocks of the kind, sheltered both from the sun and rain, but kept damp by percolation, or by the spray of adjacent cascades, at least for a great part of the year. I am greatly

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* In a letter received since notice was sent to the printer, Mr. Beaumont states that he first met with the plant so long ago as December, 1850, in Franklin County, and has enclosed to me a fruiting specimen collected at that time.

† Taking that species, as now received by Hooker, to comprise the *T. brevisetum*, R. Br.; *T. scandens*, Hedw., &c.

indebted to Mr. Beaumont for live roots of the plant, which, though carefully planted in a *Ward case*, I have not yet succeeded in causing to vegetate.

On the 8th inst. (January, 1853), Mr. Peters was so fortunate as to detect, in the same region, a second species of Trichomanes, of a small size, with undivided fronds, growing in moss-like tufts. The specimens, which I have just received from the discoverer in a letter, have very little fruit, enough however to ascertain the genus, and to show that they belong to a new species, of Hooker's first section of true Trichomanes, and of his second subdivision, which contains T. muscoides, T. erosum, T. pusillum, and T. apodum. Our new Fern is more nearly related to the first of these (chiefly a West Indian species), having the involucre equally immersed in the body of the frond (which is not the case with the other species), and the receptacle very short. But the shape of the fronds, their slender stipes, and the total absence of an intramarginal vein are abundantly distinctive characters. In the shape of the broader fronds, and in the stellate hairs which sparsely beset their margins, our plant may be likened to T. reptans; but that species has a close and flabellate venation, and a cylindrical, exserted involucre, with a deeply two-lipped orifice.

I add the characters of the species, which may appropriately bear the name of its discoverer.

TRICHOMANES PETERSII (sp. nov.): pusillum; caudicibus filiformibus tomentosis intricato-cæspitosis; frondibus (3–6 lineas longis) oblongo-lanceolatis ovato-oblongis vel minoribus late obovatis cuneatisve undulatis majoribus subpinnatifido-sinuatis obtusis glabberrimis (junioribus margine hinc inde pilis nigris 2–3-furcatis ciliatis) penninerviis in stipitem gracilem attenuatis; venis furcatis vel pinnato-ramosis liberis (intramarginali nullo); soro solitario terminali; indusio immerso tubuloso-infundibuliformi, ore dilatato libero leviter bilabiato; receptaculo (an semper?) incluso.—Hancock County, Alabama, not far from the Sipsey River; found only on the face of an isolated sandstone rock, within reach of the spray of a water-fall which is supplied for most of the season.—*T. M. Peters*, Esq.

The fronds, as in T. muscoides are very diverse in shape. The dilated-cuneate ones might be taken for the sterile form; but I observe that, more frequently than the narrower fronds, they bear a terminal indusium, which, however, is sterile and empty. There is a peculiarity about the venation; some of the branches of the primary veins being evanescent towards their base, so as apparently to lie free and independent in the frond. The slender stipe is as long as the frond itself.

ART. XXXV.—*On a method of exhibiting the Phenomena of Diffraction with the Compound Microscope;* by OGDEN N. ROOD, A.B.

[Read before the Berzelian Society of Yale College, March 8.]

WE proceed in the first place to describe a method by which any one possessing a compound microscope, may, almost without other apparatus, repeat in a highly satisfactory manner, all the ordinary experiments connected with the subject of diffraction: secondly we shall notice one or two of its bearings on microscopic vision.

For observing the phenomena of diffraction, an object lens, the half-inch for instance, is to be screwed to the lower end of the compound body, and the eye-piece is to be removed: if then the inside of the compound body is not well blackened, this must be attended to. A convenient way of obtaining a non-reflecting surface will be to coil a piece of black paper within the body. The instrument thus prepared is to be placed on a table, and a beam of sunlight thrown up through the objective by the mirror. A roll of blackened pasteboard eight or ten inches in length, and of such diameter that it will just fit around the compound body, will also be necessary. If now a piece of card or sheet-lead, having a circular aperture in the centre of about the $\frac{1}{1500}$th or $\frac{1}{2000}$th of an inch, be placed over the open end of the compound body, and the eye-piece be placed directly on the lead, and the aperture be viewed through the eye-piece, it will be seen surrounded by three or four beautiful, colored rings; the colors of the first reckoning from the centre will be yellow and dark red; the second, blue, yellow, orange, red; the third, blue, green, yellow, red; the fourth, faint green and faint red. If however the aperture be larger, ($\frac{1}{150}$th of an inch,) the eye-piece should be held at a distance of eight or ten inches from the aperture: for this purpose the roll of pasteboard is intended, the eye-piece being placed in one end of it, and the other fitting around the compound body; if then an aperture of $\frac{1}{150}$th of an inch in blackened card be viewed in this manner, the fringes will be seen, somewhat larger; there will be four sets, the colors being in the same order as above. An aperture of $\frac{1}{1500}$th of an inch or thereabouts, may readily be made by placing a piece of sheet-lead on some hard substance, as a steel plate, and then pressing a fine needle into the lead. If the aperture be too large for being viewed in either way, the rings will be much broken. Next substitute for the aperture a slit in brass or tin-foil, the $\frac{1}{200}$th or $\frac{1}{1100}$th of an inch in diameter. In the first case it should be viewed by the eye-piece at ten inches distance, in the second the eye-piece may be placed directly on the slit: a white space will be seen running across the field bordered on either side by broad bands of yellow, red, blue, yellow, red, green, &c.; the colors following in the order given above Four orders can in this way be observed; the phenomenon is exceedingly beautiful, the colors being very brilliant. By using a micrometer eye-piece, certain proportions which were observed by Fraunhofer to obtain among the bands, may be noticed. The experiment of the slits generally succeeds better than that of the circular apertures, though if the slits are not perfectly regular, the bands following in an inverse manner the irregularities, will be arranged in jagged lines. For observing the rings of color or of darkness formed *within* circular apertures or slits, gas light is preferable, though they may be shown by sunlight. A circular aperture, $\frac{1}{35}$th of an inch is placed over the open end of the compound body, and the eye-piece fixed in the pasteboard is held at about five inches distance. A white circular image of the aperture will be seen, and within it two small rings of blue and red. If the eye-piece be placed on the aperture, or on a larger one, rings of darkness will be observed. If the same plan be pursued with slits, *lines* of color or of darkness will of course be seen.

But if on the other hand, the edge of a piece of blackened card be introduced into the beam of divergent light, and the eye-piece placed upon it, it will be seen bordered by dark lines running parallel to its edges, and fine lines of light will project some distance into the shadow. When the eye-piece is removed ten inches the dark lines develop into colored fringes. If a piece of iron wire, $\frac{1}{100}$th of an inch in diameter, be placed as above, with the eye-piece at 11 inches, the centre of its shadow will be occupied by a line of light: if the wire is as fine as $\frac{1}{200}$th of an inch, the eye-piece may be placed directly on it. With a larger size, and the eye-piece properly placed, six or seven lines of light and darkness can be distinctly seen; and in general the external fringes will be distinct in proportion to the small size of the wire, while the internal lines are the reverse to a limited extent. If a circular opaque body, $\frac{1}{12}$th or $\frac{1}{15}$th of an inch be placed on a plate of thin glass, and viewed by the eye-piece at ten inches, besides the external fringes a circular white spot will be seen in the centre of the shadow, as though the body had been perforated. If fine chalk powder, &c., be sprinkled on the glass plate, and viewed by the eye-piece at ten inches, it presents an appearance of numerous fine dark lines, arranged in minute circles, their diameters being inversely as the size of the particles of dust.

For repeating some of M. Fraunhofer's experiments on gratings, an ordinary stage micrometer, having equi-distant lines ruled at $\frac{1}{400}$th or $\frac{1}{500}$th of an inch apart, may be used. This when placed as above, shows a white space in the middle, with a certain number of prismatic spectra on either side, the purity of the colors being dependent on the regularity with which the lines are ruled. With lines $\frac{1}{400}$th of an inch apart, five spectra on either side were observed. If however the cornea of a fly be taken as a grating, and viewed at 11 inches, a central white spot is seen, surrounded on all sides with great numbers of prismatic spectra. The appearance is one of great beauty.

Having thus described an easy method of performing experiments on diffraction, we proceed to notice one or two of its bearings on microscopic vision. And we would state in the outset, that all the experiments alluded to above may be performed by the microscope when arranged as it ordinarily is for observation; that is, let an inch or a half inch objective be screwed on, the eye-piece being in its proper position; let parallel rays of the sun be thrown up through the body by the plane mirror, and let an aperture $\frac{1}{1500}$th or $\frac{1}{2000}$th of an inch be placed on the stage and viewed as an ordinary object. As long as the aperture is in focus, nothing remarkable will be observed, but if the compound body is carried within or without the focus, the aperture will be seen to dilate and to become surrounded with colored rings precisely as above. Reckoning from the centre, the rings will be yellow, dark red, blue, yellow, red, blue, &c. If a fine slit be used instead, the same sets of colored bands are seen as described above; in either case, as the object lens approaches the focal point the rings or bands contract and disappear. By turning the light a little obliquely, so as to make it faint, or by using a larger aperture with rather faint sunlight, dark rings or lines can be observed in the centre of the white spot. If the edge of an opaque body be brought into the field of sunlight, and if it is a little out of the focus, it will be seen bordered with the same dark or colored lines as described above. To observe the internal fringes let a piece of fine wire, ($\frac{1}{200}$th of an inch,) be placed on the stage, and viewed a little out of the focus, it will be seen filled up internally by lines of light and darkness; three or four external fringes in the shape of distinct black lines will also be seen on either side. If a very fine scratch on glass be viewed in this manner, the external fringes will be well developed; reckoning from the centre, they will be, blue, yellow, red, blue, &c., this being the case when direct parallel rays of the sun are used, the phenomena being different with oblique light.

We have now seen that when the direct rays of the sun, or a lamp are used, we must expect to find the appearance of microscopic objects modified by diffraction; for, using high powers with the best fine adjustment, all parts of the object cannot generally be in the focus at the same time: consequently it will be observed that when under a power of even 200 diameters, the object being most accurately focused, it exhibits marked phenomena of diffraction. Let us now take one of the simplest cases of bodies viewed by oblique light, viz. a single fibre of black silk, a single strand of a spider's web, or a fine scratch in glass; let it be viewed under a power of 400 diameters, the light being that of the sun, thrown obliquely across the object most accurately focused. The object will be seen to dilate, and three bands of color, blue, red and yellow, will represent it; the colors all broad and distinct. Within the bands and running parallel with them, are great numbers of fine dark lines, placed very near to each other, and with considerable regularity, and in fact closely resembling the lines on certain test objects; moreover, it would seem that the better the object lens, the more distinct the lines become. That these black lines are only fringes of diffraction may be readily shown, for by moving the compound body a little out of focus, they develop into the ordinary colored fringes. If the line be a strand from the spider's web, the fine black lines are very abundant, and extend on one side a considerable distance beyond the colored space. If a fine scratch on glass be viewed in this manner, under 400 diameters, the light can be so arranged that it shall exhibit the same phenomena; in general, if the line has any breadth, and if it be rotated so that the light is thrown along its length, a position will ordinarily be found when the external fringes for the most part disappear, while the internal ones, if there are any, become more distinct. The foregoing may perhaps throw some light on the fact that so many persons see longitudinal lines on test objects, (Naviculæ,) while they fail to show the transverse; but nevertheless, in using very oblique sunlight not only is a single line always accompanied by many parallel fringes of diffraction, but after these have been made to disappear by revolving the line, often a distinct set of *transverse* lines at right angles to the former take their place. It would seem from these facts that perhaps central light is as safe in testing objectives as any other.

In viewing fine gratings *under* the microscope, that species of illumination called background should be employed, and instead of an artificial grating which could not readily be procured sufficiently fine and regular, use scales of the Lepisma saccharina, or of the Lycena argus, both of which have parallel markings. It will be noticed that when the light is thus thrown along the lines, the scale is generally of a dull blue; on revolving it slightly it changes from blue to bright red, to orange, to yellow: at the next stage it is very bright and slightly tinged with blue: turning it farther, it changes from yellow to red, to the original dark blue. When it has reached its maximum of brightness, if the compound body be carried out of the focus, one or more beautiful prismatic spectra will be developed by the lines on the scale, consisting of red, orange, yellow, green and blue. Some scales of the Lepisma, with the one inch objective, show two similar spectra side by side, others three; others again, one principal spectrum near the spot where the image of the scale vanished, and another faint spectrum which advances or recedes from the principal one, as the compound body is moved up and down. The distinctness of the colors in these spectra, depending as they do on the regularity with which the lines are drawn, furnish a means of forming a judgment on this point. The spectra are of course formed at right angles to the direction of the lines. By means of these spectra the existence of lines on certain scales was detected, when the power employed, (40 diameters) was wholly unable to exhibit them; in fact, to show the lines distinctly, a power of 300 diameters with oblique light was found necessary.

The phenomena of diffraction also afford a ready explanation of the small concentric circles which are so often seen covering slides containing microscopic objects: they are of course owing to exceedingly fine particles of dust which produce dark rings, the size of which is inversely as that of the particles of dust. Of the same nature are the minute rings seen when looking through the microscope without any object on the stage; in this case the dust will be found on either lens of the eye-piece.

Speaking of small particles of dust, &c., it may not perhaps be amiss to mention a method of obtaining a measure of small points or of very fine lines, which method has however nothing to do with diffraction. The eye-piece micrometer is used; after making the proper determinations to ascertain the value of the spaces between the ruled lines, the graduated slip of glass is removed from the eye-piece, placed on the stage, and the proportion which the thickness of a single line on the graduated glass bears to the distance between two lines, ascertained for one line by the proper measurements. In one case this was found to be $\frac{1}{60}$th; that is, the space between two lines was 60 times the thickness of a particular line. Let now the slip of glass be replaced in the eye-piece, and suppose that with a power of 400 diameters, the space between two lines corresponds to $\frac{1}{2000}$th of an inch; it is evident that the breadth of the particular line determined is now = $\frac{1}{60}$th of $\frac{1}{2000}$th; that is, equal to $\frac{1}{120000}$th of an inch. This of course can be directly compared with lines, dots, &c. on test objects. In the case above mentioned, the line determined was quite coarse—could readily be seen by the naked eye; by using a fine line in the micrometer eye-piece, it is evident that this method admits of being carried much farther.

In conclusion, we would remark that this subject seems worthy of an extended investigation, not only on account of the modifying influence diffraction exerts on the appearance of microscopic objects, but also because it is probable that by a skillful use of phenomena of diffraction, we should be able to detect, indirectly, the existence of certain kinds of structure, when the best objectives had wholly failed to demonstrate it.

ART. XXXVI.—*On Minerals accompanying Chromic Iron*; by THOMAS H. GARRETT.

IN a former essay in this Journal, (vol. xiv, p. 45,) I embraced only chromic iron, and in the present I propose to introduce several of the minerals accompanying it.

Kämmererite.—This beautiful mineral occurs in considerable quantity in chromic iron and its associated serpentine at Wood's Pit, and at the mine on the line between Pennsylvania and Maryland, a few miles from Texas, Lancaster Co., Pa. It forms vein-like projections in the ore and serpentine, or lines seams between the ore and its enclosing talcose minerals.

Its structure is micaceous or foliated, fibrous, and graduates from these into a massive variety. The foliated passes into talc, the fibrous into hornblende, and the massive into serpentine. The more compact portions present the characters of Rhodochrome, and since Hermann's analyses of the two minerals from L. Iktul indicate similarity, I conclude that Rhodochrome is an impure form of Kämmererite. That it is a distinct chemical compound is shown by its crystalline form, which I have observed in several specimens, and which is described by Hartwall as a hexagonal prism. The form is right rhombic, presenting hexagonal tablets with bevelled edges. The combinations are the vertical rhombic prism with the large main end plain and small lateral end planes, (forming a hexagon,) a lateral rhombic prism on the edges of the end planes, and the octahedron replacing the edges of the vertical rhombic prism.

The following are the results of my analysis of a pure specimen, between fibrous and foliated, and selected with care.

Silica, ...	37·657
Oxyd of chrome, . . .	3·604
Alumina, ...	11·823
Magnesia, ...	24·974
Lime, ...	4·113
Protoxyd of iron, . . .	2·499
Protoxyd of nickel, . . .	0·672
Water, ...	13·582
	98·924

The simplest formula according to the analysis would be $2(R_2O_3, 3SiO_3)+11(RO, HO)$. And here I may be allowed to draw attention to a remarkable feature among some of the numerous talcose minerals; that in a large proportion of them the number of equivalents of water and of RO bases is equal. Hartwall's formula for Kämmererite is $2(RO\,SiO_3)+R_2O_3, SiO_3+6HO$, although $5\frac{1}{2}HO$ satisfies the analysis more exactly. Dr.

Genth has recently analyzed the same mineral from Lancaster Co., and given it the name of Rhodophyllite, with the formula $3(RO\,SiO_3)+2(R_2O_3, SiO_3)+9(MgO\,HO)$ which agrees well with his analysis. Hermann's recent analysis of the same mineral from the Ural is unquestionably erroneous.

I do not therefore consider the true formula of Kämmererite as absolutely determined, and since these hydrotalcose minerals insensibly pass into each other, Dana has undoubtedly acted judiciously in placing Kämmererite under the previously determined Pyrosclerite, especially as they are both trimetric.

Bronzite.—This mineral is repeatedly seen in the serpentine near Texas, half a mile west of the village, constituting large masses, which are highly crystalline, foliated and fibrous. A selected specimen from this locality yielded:

Silica, ...	55·451
Alumina, ...	1·127
Magnesia, ...	31·832
Protoxyd of iron, . . .	9·603
Protoxyd of manganese, . .	0·984
	98·997

Although parts of the same mass were penetrated by chromic iron, yet neither chrome nor nickel have influenced the Bronzite. Its formula is $RO, Al_2O_3+14(3RO, 2SiO_3)$, the first member is evidently an impurity, and the last which is the true formula of the mineral, is that of Augite, and not that of Anthophyllite, as it has been generally called. It will be observed to agree closely with the Bronzite from Ultenthal, analyzed by Regnault (Dana's Min. 3d ed., p. 269), but the mineral from Texas is not characterized by the usual metalloidal lustre of Bronzite.

Emerald Nickel.—This mineral with its brilliant green color, contrasts strongly with the lustrous black of the chromic iron in which it occurs, and with the purple or lilac hue of Kämmererite. It either forms so thin a coating upon the chromic iron or talcose minerals, or is so intimately and uniformly blended with the latter, that I have not been able to obtain a specimen sufficiently pure to determine its exact composition. The following analysis was made of small fragments selected with great care:

Silica, ...	36·823
Alumina and oxyd of iron, .	1·396
Magnesia, ...	16·579
Lime, ...	3·839
Oxyd of nickel, . . .	30·837
Carbonic acid, . . .	4·363
Water, ...	8·551
	102·388

The oxyd of nickel may be in slight excess. The proportion of equivalents is,

SiO	MgO	CaO	NiO	CO_2	HO
8	8	1⅓	8	4	9½

If we may theorize upon such a complex composition, I would suggest as the most likely grouping of the mixture:

$4(2NiO, CO_2, HO)$ Emerald nickel (pure).
$6(MgO, SiO_3, HO)$ Meerschaum.
$3MgO, 2SiO_3$ Augite.

I have not found a single specimen, which upon treating with acid, will not show a white talcose residuum, which appears to be Meerschaum, and not Marmolite as I had at first supposed.

Dolomite.—It is found in crystalline masses with mamillary surfaces lining cavities and fissures in the serpentine rock near Texas, and that surrounding the chromic iron at Wood's Mine. It yielded:

Carbonate of lime, . . .	51·90
Carbonate of magnesia, . .	46·86
Carbonate of iron, . . .	1·24
	100·00

The proportion indicated by the analysis is almost exactly $CaO, CO_2 + MgO, CO_2$. Although magnesia is in very great excess, and lime in minute proportion in the adjoining rocks, and even large deposits of hydrocarbonate of magnesia occur, it is interesting to find the percolating waters forced by the stronger affinities of lime to share its solvent power between magnesia and lime in equivalent proportions.

ART. XXXVII.—*On the Causes which may have produced Changes in the Earth's Superficial Temperature;* by W. HOPKINS, Esq., M.A., F.R.S., Pres. G.S., and Pres. Cambridge Phil. Soc.

(Concluded from p. 259.)

3. *Discussion of the Relative Claims of the preceding Hypotheses.*

I HAVE already stated that I considered the hypotheses discussed in the first part of this memoir entirely insufficient to account for any sensible changes of terrestrial temperature in the later geological periods, as they obviously are to render account for a change from a lower to a higher temperature. In the earlier periods of the earth's history, supposing our globe to have been originally in a state of fusion, as there are many reasons for believing it to have been, its superficial temperature must have been greatly affected by its internal heat long after the solidification of its surface had commenced. Undoubtedly this cause may be appealed to as sufficient for the production of almost any amount of terrestrial temperature; but, if the temperatures thus to be accounted for be many degrees above the existing temperatures, we can account for them by this theory only with reference to periods of very remote geological antiquity. I have also shown that any sensible effects of a difference of intensity in stellar radiation can be referred only to similarly remote epochs, and even for those periods the theory founded upon this notion appears to me vague and unsatisfactory.

Another theory of the changes of terrestrial temperature has been founded on the notion of a variation in the intensity of solar radiation. This cause, once admitted, might undoubtedly be deemed adequate to account for all the changes in question, nor does there appear to be any well-defined *à-priori* objection to it. No theory, however, can be satisfactory which presents itself as a mere hypothesis framed to account for a single and limited class of facts, and unsupported by the testimony of any other class of allied, but independent phenomena. The reception of such a theory must always be accompanied with great reserve, and must depend less on its own positive claims, than on an equal or greater want of such claims on the part of rival theories.

The theory which attributes the changes of terrestrial temperature to a varying configuration of land and sea is scarcely less indefinite than the others in its direct application to account for the difference of temperature between the present and the very remote geological epochs, on account of our ignorance of the disposition of sea and land in any but the most recent geological times. In the more remote periods, more than one of the causes here specified may have had their influence; but in accounting for the more recent changes of temperature, the last mentioned theory appears to me to have by far the greatest claim to our attention. I have endeavored in the preceding sections of this second part of my memoir to trace the consequences of certain hypothetical configurations of the earth's surface, and to explain the conditions under which a degree of cold might exist adequate to produce the phenomena of the Glacial Epoch. I propose in this concluding section to offer a few leading observations on the relative claims of these different hypotheses to our acceptance.

30. The most obvious mode of producing a great degree of cold is by local elevation. If we attribute the former presumed cold of western Europe to this cause alone, it would be necessary as I have shown (§ 24, p. 253), to elevate the whole region into a vast mountain-range, attaining in some parts the height of 10,000 feet or upwards. But all geological experience assures us that no such mountain-range exists without numerous dislocations and other phenomena of elevation having determinate relations to the

elevated tract. Of such characteristic phenomena not the slightest traces have been recognized. If it be urged that the elevation might be more local than here supposed, I would reply that such an hypothesis would rather strengthen than weaken the objection: for the more local the elevation, the more certainly, I think, would it be accompanied with dislocations which could not escape detection. I should reject without hesitation any theory founded on the hypothesis of an elevation during the glacial period, at all approximating to that which would be necessary to produce the required degree of cold.

31. Again, a great degree of cold might be produced by the conversion of a sufficient portion of the Atlantic into dry land. But this would also require an elevation of western Europe, probably of several thousand feet (§ 25, p. 254). Now if the cold of the glacial epoch were thus produced, this enormous area of the Atlantic must have been uplifted from its former level immediately previous to that epoch, and must since have again subsided. Considering the probable depth of the Atlantic Ocean, this movement must indeed have been enormous, and yet, although occurring at the most recent geological period, not a trace of it is observable either on the European or American side of the Atlantic. Under any circumstances, a theory founded on such an hypothesis, would, I think, be most unsatisfactory, and cannot be accepted in opposition to any other theory which may be free from objections of so grave a character.

We may also observe, that any theory of the production of cold solely by the *elevation* of the regions presenting glacial phenomena would be insufficient to account for many of these phenomena. It would be necessary that such a theory should embrace also the *depression* of such regions beneath the level of the sea, either before or after their elevation, for some of the phenomena in question may be referred to floating ice and currents of water with quite as much certainty as others can be to the action of glaciers.

32. Again, I have shown that the requisite degree of cold for the production of glaciers might arise from the diversion of the Gulf-stream into some other channel, the submergence of a great portion of the existing European continent, and a cold current from the north. This diversion of the Gulf-stream might be produced by the elevation of a portion of the bed of the Atlantic so as to form connecting land between the most western part of Africa and the most eastern portion of South America. But this would require an enormous movement, of which, I believe, not the slightest geological indication has been recognized, and the hypothesis is therefore liable to the same objection as that which may be made against the supposition of the more northern portion of the Atlantic having been elevated into dry land during

the glacial period. But there is another mode in which the diversion of this great current may, as it appears to me, have been effected, and to which I would especially direct the attention of geologists.

33. On the west of the continent of North America, a continuous and lofty range of mountains, the Rocky Mountains, extends from Mexico to the Arctic Sea. Another, but far less lofty chain, the Alleghanies, runs parallel to the eastern coast from near the Gulf of Mexico to the St. Lawrence. The great valley of the Mississippi and its tributaries, extending over some 30° of longitude, occupies the southern portion of the space between these two mountain-chains, being bounded on the south by the Gulf of Mexico, into which the Mississippi discharges its waters. In proceeding from the mouth to the source of this great river, we ascend about 1500 or 1600 feet.* Proceeding northward from its source, we descend into the great valley extending from the Gulf of St. Lawrence, on the eastern coast, along the great chain of North American lakes, to the mouth of the Mackenzie River, which discharges itself into the Arctic Sea. Thus a depression of 2000 feet would convert the valley of the Mississippi into a great arm of the sea, of which the present Gulf of Mexico would form the southern extremity, and which would communicate at its northern extremity with the waters occupying the submerged district above described as the great valley now occupied by the chain of lakes. A direct communication would thus be produced between the Gulf of Mexico and the Arctic Sea along the eastern base of the Rocky Mountains.

The Gulf-stream, flowing through the Straits of Bahama, and afterwards, in its northeastern direction, towards the North Sea and the coasts of Europe, is a current reflected from the shores of the Gulf of Mexico in consequence of the impossibility of its continuing the northwestern course by which it reaches the Gulf. But in the case now supposed, a direct opening would be made exactly in the direction which the current would continue to follow if uninterrupted. Its continuance to the Arctic Sea, and its non-reflection through the Straits of Bahama, would be the obvious consequences of the depression of the continent of North America. It would thus lose all sensible influence on the coasts of western Europe, but it would necessarily increase the temperature along its new course, and especially in the cold region of northwestern America towards the present shores of the Arctic Sea. The northeastern portion of the present continent would probably be much less affected by it.

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* See Sir John Richardson's paper "On some points of the Physical Geology of North America," Quart. Journ. Geol. Soc., 1851, vol. vii, p. 212.

34. It is probable that every great oceanic current must have its counter-current. Now, if the mass of water constituting the Gulf-stream were poured, as here supposed, directly into the Arctic Ocean, the only course, which any great counter-current from that ocean could follow, would seem to be through the North Sea intervening between the coasts of Norway and Greenland, and across the submerged portion of northern Europe. There would in fact be no other considerable opening from the north; for even if we suppose the low lands of northern Asia to be submerged, the mountain-ranges of that region would still offer an insuperable bar to any egress, except in the direction above indicated, for the waters of the Arctic Ocean. The opening through Behring's Straits would probably not be worthy of notice. These considerations appear to me to increase considerably the probability that this diverted course of the Gulf-stream would be attended by a cold current over the region now occupied by the continent of northern and western Europe.

35. The theory which I have here proposed respecting the diversion of the Gulf-stream, is not to be regarded as resting on an hypothesis framed simply to enable us to account for a particular class of phenomena. I regard it, on the contrary, as resting on a necessary inference from the submergence of the North American continent; for, I repeat, if that continent were submerged to the depth implied, as I believe by the most conclusive geological evidence, the course of the Gulf-stream could be no other than that which I have assigned to it. It is necessary, according to this view of the subject, to suppose this to have been the course of the current during the period of greatest cold in Europe, but it is by no means necessary to extend the supposition to the whole period of submergence of a great portion of the American continent. Many of the glacial phenomena of that region might be produced during its partial submergence, before the depression of the land was sufficient to admit the current to the Arctic Sea, or after its course had been again impeded, or altogether arrested, by the partial subsequent elevation of that continent. During the uninterrupted course of the current to the north, it would doubtlessly, as I have above remarked, increase, and probably very much increase, the temperature of the region corresponding to the present shores of the Arctic Sea; for nearly the whole of that mass of warm water, which now elevates so remarkably the temperature of the northern Atlantic up to the North Sea, would then proceed to discharge itself into the Arctic Sea between the Rocky Mountains and Hudson's Bay, by a course shorter, more direct, and probably therefore more rapid, than that by which it now reaches the coast of Iceland. I should consider it most probable that it would produce a temperature in the region along the northeastern flank of the Rocky Mountains, and extending

to the present northern shores of the American continent, higher than that of Iceland, and more nearly resembling that of some parts of our own island.

After having arrived at this conclusion, I was naturally anxious to learn whether any distinct indications had been observed of this climatal condition of the region in question, and recollecting to have heard my friend Prof. E. Forbes make incidental mention of the discovery in high northern latitudes of vegetable remains indicative of a temperature considerably higher than the existing temperature, I wrote to him, stating my own conclusions, to ascertain the precise locality in which these remains had been found, and the period to which they belonged. A few days ago I received his reply, stating that these plants might belong to the pleistocene period, and that the locality in which they had been found was precisely that above spoken of, along the flanks of the Rocky Mountains and between them and Hudson's Bay, as the region of which the temperature would probably be so much affected by the warm current from the Gulf of Mexico. I cannot but regard these remains as strongly confirmative of the view which I have now ventured to propound.

But how, it may be asked, could such a warm current be consistent with the glacial phenomena of the North American continent? I have already intimated the reply to this question. The exact period of these phenomena might be either anterior or posterior to that during which the Gulf-stream made its way to the Arctic Sea. Suppose the superficial configuration of that continent previous to its submergence to have been similar to its present configuration. A gradual subsidence might convert the northern portion of the continent into an arctic sea long before a free northwestern course would be opened for the Gulf-stream. With the exact similarity of the former and present configuration this extended arctic sea would be bounded towards the south by the higher land which now constitutes the watershed between the great northern valley of the chain of lakes and that of the Mississippi; but if the former and present configurations of the land were only approximately and not accurately similar, or if the submergence were more rapid in the north than in the south, the boundary of the extended Arctic Ocean might pass further to the south, and comprise, for instance, the northern part of the valley of the Mississippi, before the Gulf of Mexico extended its waters much to the north of its present boundary. In like manner, similar conditions might obtain during the subsequent emergence of the land. Minor hypotheses of this kind, entirely subsidiary to the general hypothesis with which they are associated, must be considered as always admissible, and can only be tested by observed phenomena. One remark, however, should here be made. The periods of greatest cold in America and western

Europe respectively could not, according to this theory, be *exactly* synchronous. Assuming, as we have done, the Gulf-stream to have existed during the supposed changes of level of the North American and European continents, it must have exerted its warming influence in the more northern latitudes, either as a direct current along the flanks of the Rocky Mountains, or as a reflected one on the western coasts of Europe. The cold due to the absence of its influence in both these regions could not be strictly simultaneous, although belonging to the same geological period. This is an essential conclusion of the theory. I know not whether there are any geological facts which tend either to favor or oppose it.

36. It only remains for me to say a few words respecting the hypothesis made in the early part of this memoir (§ 14, p. 78) of the continuity of land from the north of Scotland to the coast of Greenland. I have stated my opinion that the mean temperature along such a northern shore of the Atlantic might be increased 4° or 5° F., and that the winter temperature would probably be much the same on the coast of Iceland as in the latitude of central France. The climatal change might possibly be still greater than here estimated.

M. D'Orbigny has observed about a dozen species of sublittoral molluscs in the West Indies, which he regards as identical with species now inhabiting the western shores of the old continent in corresponding latitudes. Now admitting the theory of the dispersion of specific forms from single centres, this identity of species would imply some connection between these localities on opposite sides of the Atlantic, either by dry land or a shallow sea-bottom. I have already stated (§ 32) the grave difficulty which besets the hypothesis of a barrier of land across the Atlantic, and a similar difficulty must attach to the hypothesis of a shallow sea-bottom. The continuity of the northern shores of the Atlantic warmed by the Gulf-stream may possibly enable us to avoid the far more difficult hypothesis just mentioned. I merely suggest this hypothesis, however, for the consideration of those who may adopt the above opinion of M. D'Orbigny, and draw from it the inference of a former connection between the localities in which the identical species are found.*

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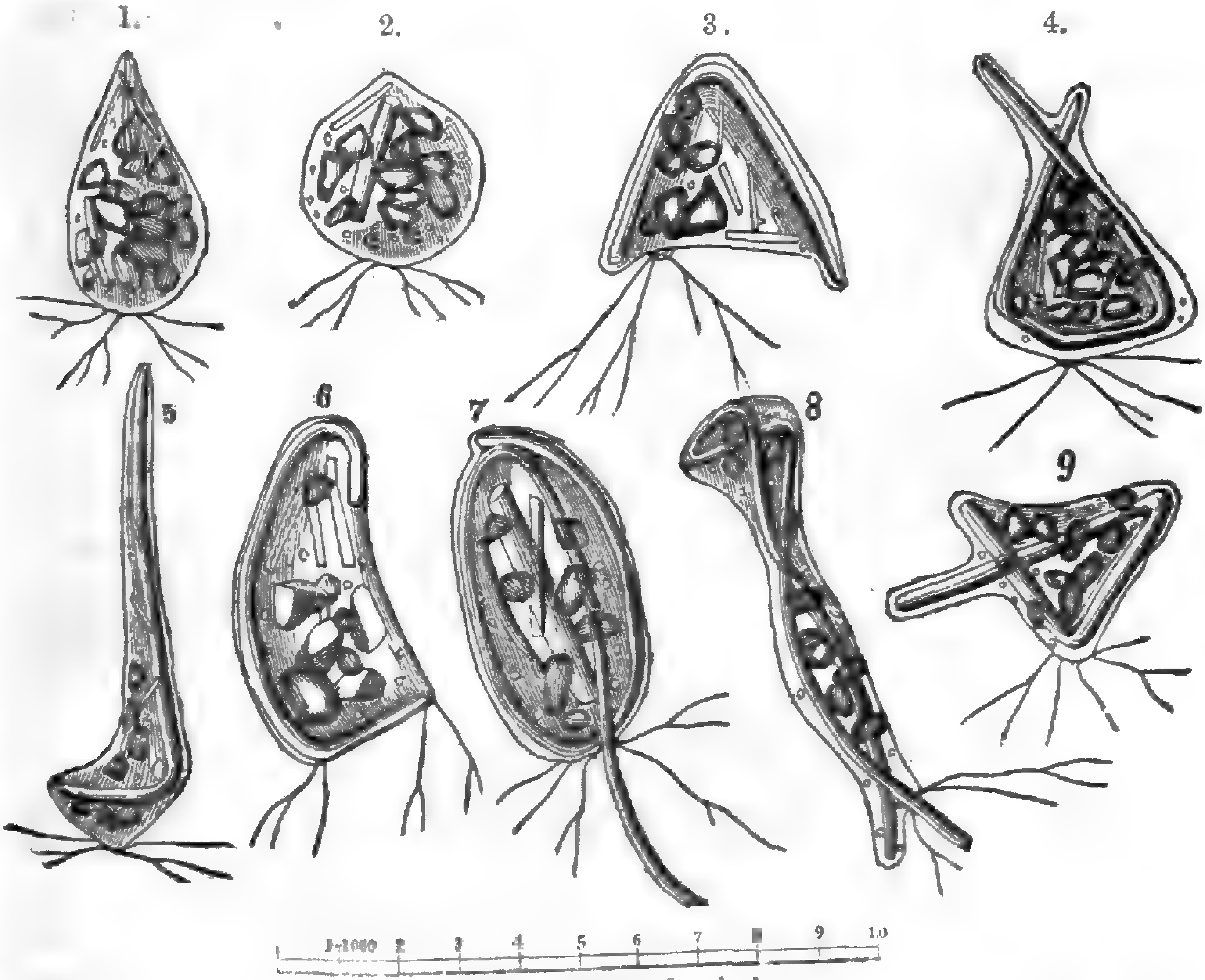
* A note will be found towards the close of this volume on the isothermal chart illustrating this paper, issued with our March number.

ART. XXXVIII.—*Observations on a newly discovered Animalcule;* by J. W. BAILEY.

THE animalcules described in the following pages were found in great numbers in the bottom of a small vessel or "aquarium," in which colonies of Plumatella, Melicerta, and Limnias had been kept. Of all the forms which can with certainty be referred to the animal kingdom, there are few which at first sight are so little likely to be recognized as animals as those about to be described.

If the reader will imagine a bag made of some soft extensible material so thin as to be transparent like glass, so soft as to yield readily by extension when subjected to internal pressure, and so small as to be microscopic; this bag, filled with particles of sand, shells of Diatomaceæ, portions of Algæ or Desmidieæ, and with fragments of variously colored cotton, woolen, and linen fibres, will give a picture of the animal; to complete which it is only necessary to add a few loose strings to the bag, (figs. 1 and 2,) to represent the variable radiant processes which it possesses around the mouth.

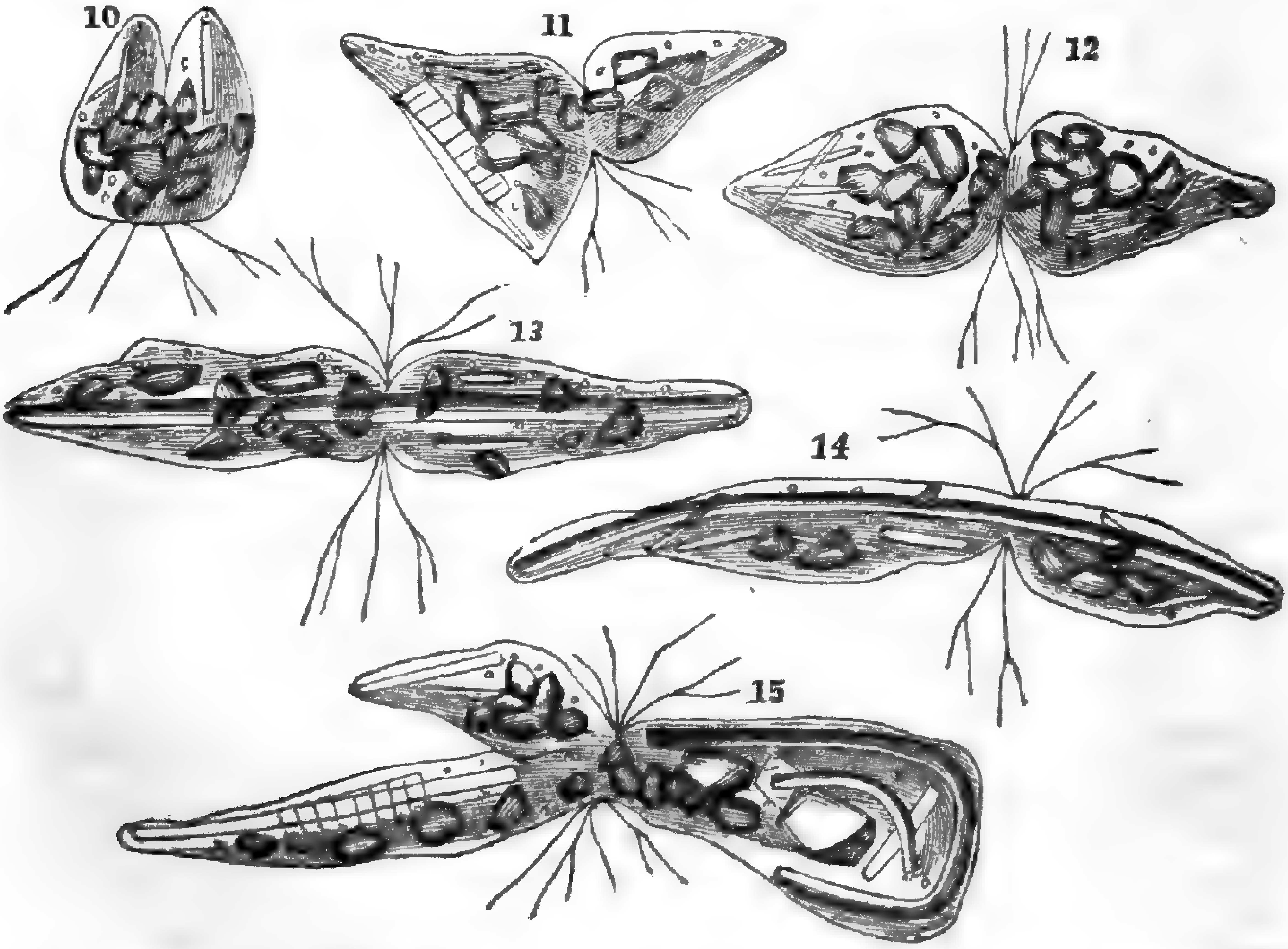


Scale of ten 1000ths of an inch.

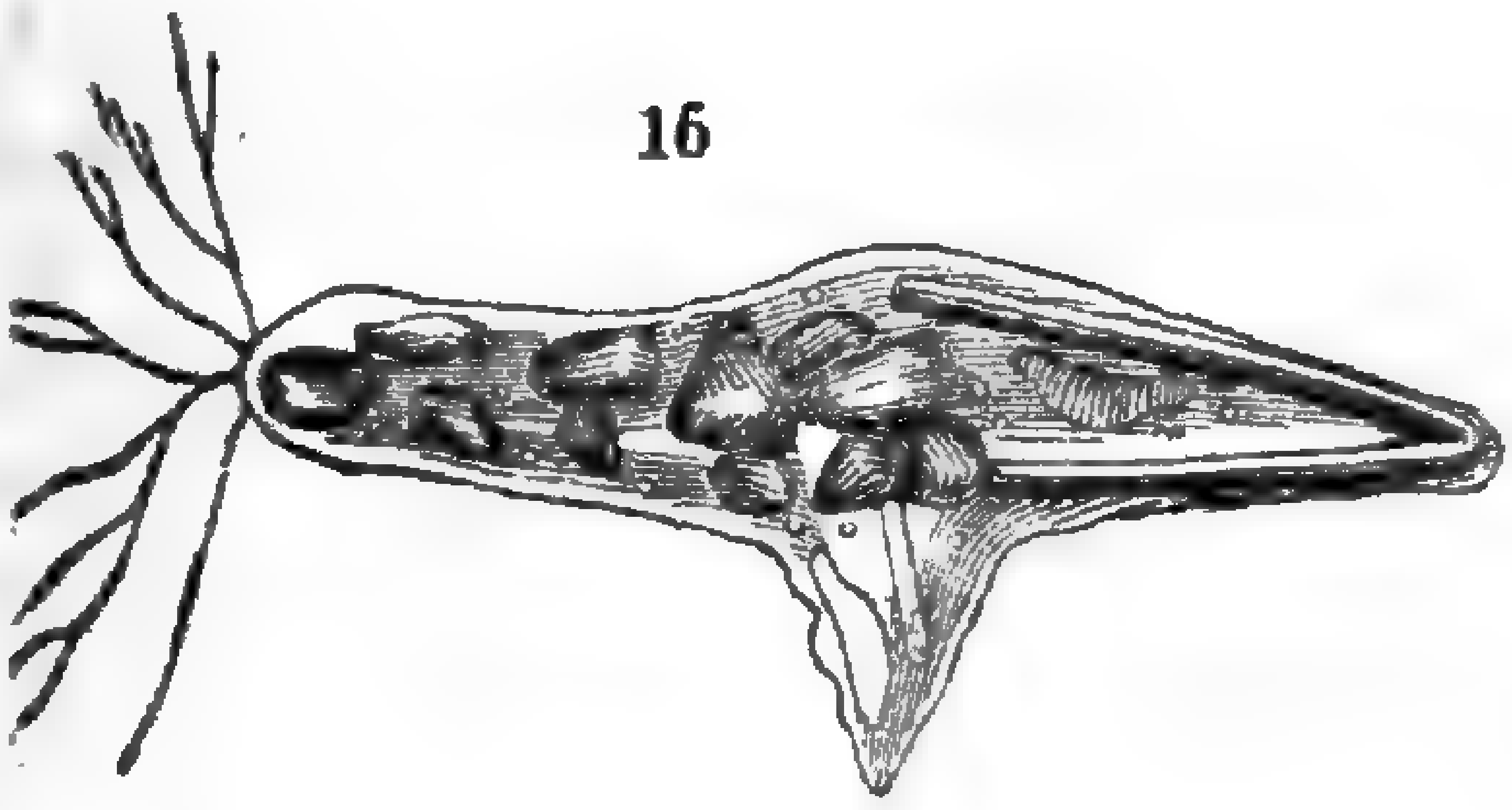
When I first saw these curious creatures they attracted but little attention, as I supposed they were merely excrementitious masses due to some of the aquatic animals living in the vessel where they occurred. A more careful examination showed that they moved spontaneously and even with some degree of rapidity; and that this motion was due to radiant, branching, and variable feelers, or "rhizopods," which were thrown out near one extremity. By attaching these feelers to various objects the animal was enabled by means of them, to pull itself along, or to change its position at will.

The most common form in which these creatures occur is that of a pear-shaped mass (fig. 1) having the feelers attached to the larger end, while the other end appears almost always to be pushed out and rendered acute by the presence of several long diatomaceous shells which the animals have swallowed. A globular or pyriform state (figs. 1 and 2) may be considered as the normal condition of these creatures; but the imagination can scarcely conceive of forms more varied and extraordinary than they assume in order to accommodate themselves to the shape of substances which they may have swallowed.

A better idea than words can convey of these bizarre shapes will be obtained by a glance at some of the figures, (figs. 3, 4, 5, 6, 7, 8, and 9, on the preceding page,) in which are represented various individuals in the shapes they presented after swallowing bits of woolen, cotton, or linen fibres derived from the dust of the room in which they were kept.



Another curious set of forms appears to be produced by the process of spontaneous fission or self-division, for I know not in what other way to explain such forms as those represented in figs. 10, 11, 12. It will be seen that these figures show what appear to be all the stages of fission from a slight depression in the posterior portion as in fig. 10, to an almost complete separation into two individuals, as in fig. 12, where a narrow isthmus alone connects the two portions. Although these successive states have not as yet been seen to occur in the same individual, I think the figures just referred to leave little doubt that the process of spontaneous division so common among animalcules is possessed by the creatures now under consideration.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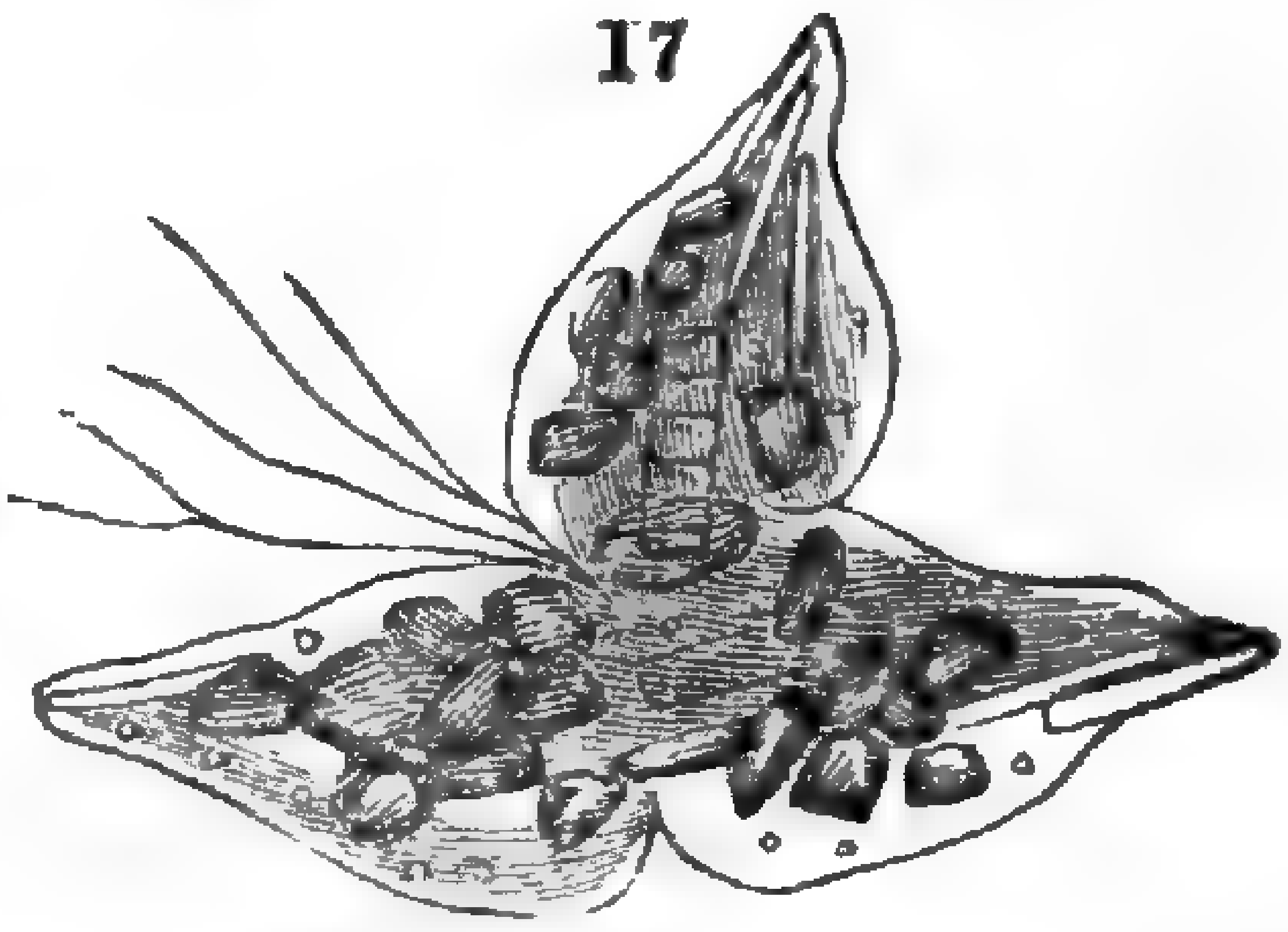
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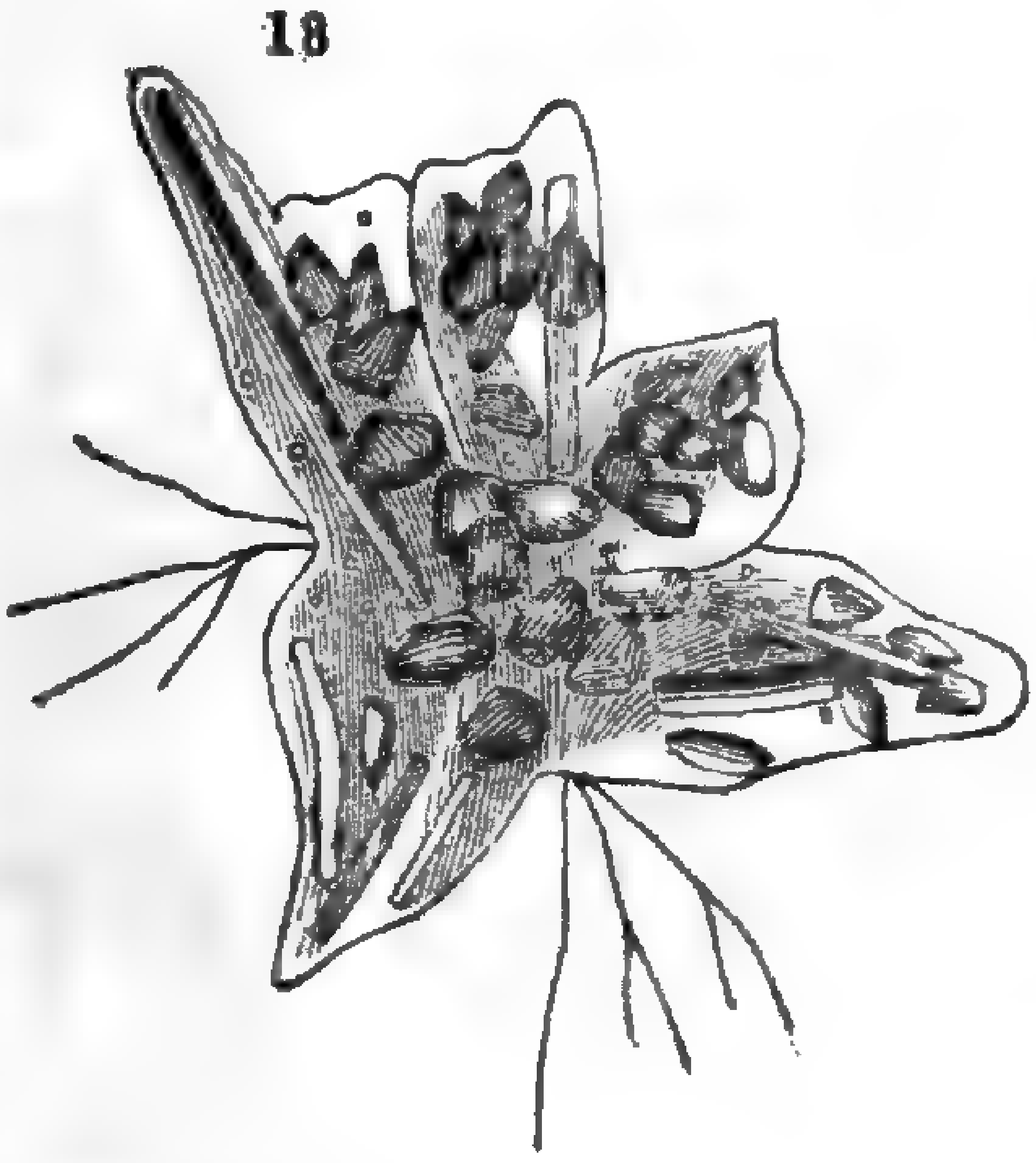
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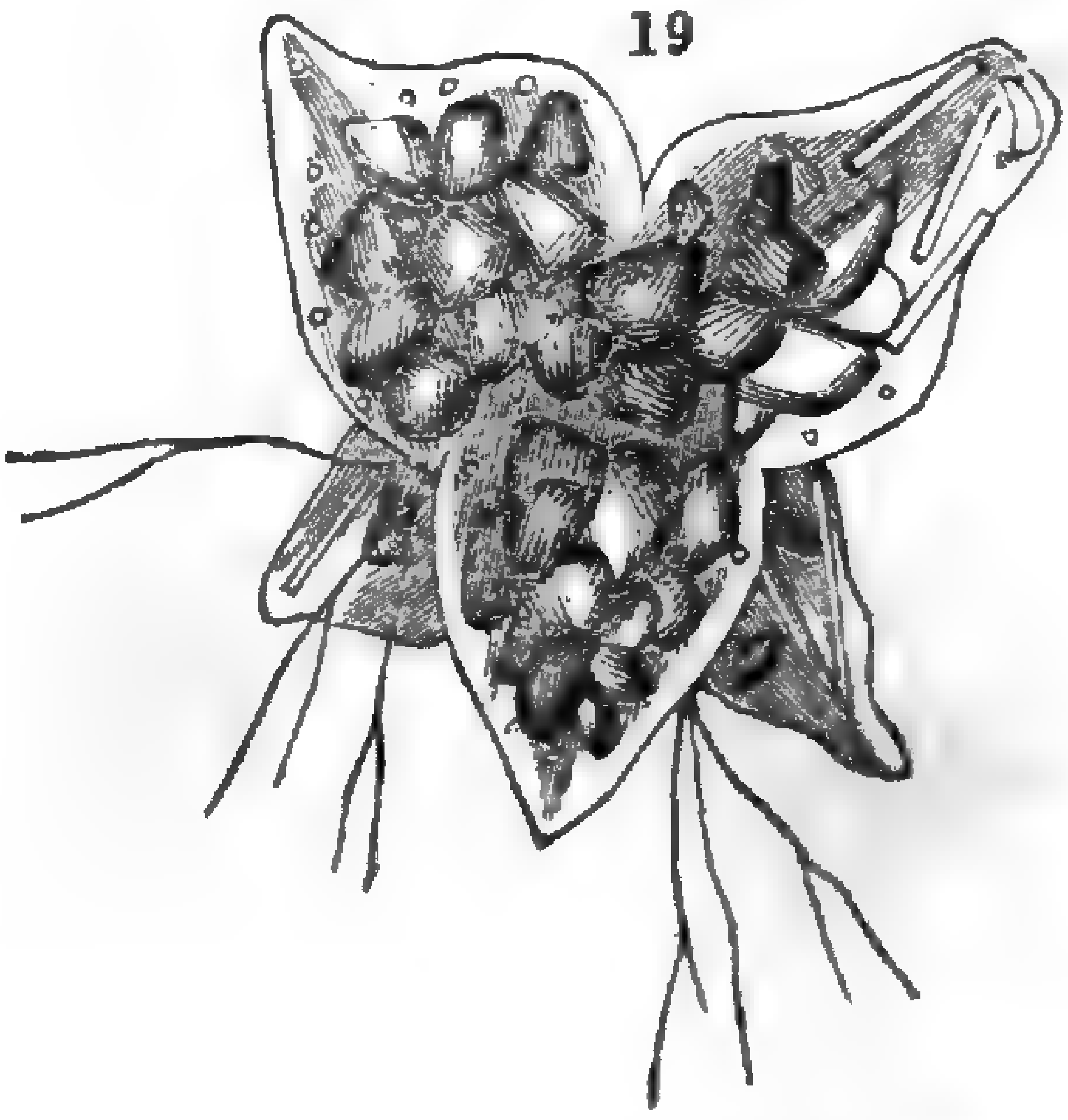
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The partial fission, or a budding from the sides, when combined with the distortion produced by the internal pressure of the various articles swallowed, gives rise to the complex and extraordinary forms shown in figures 13, 14, 15, 16, 17, 18 and 19. Some of these appear as if several pear-shaped individuals were about to be produced by a budding from the sides of the parent, but it is also certain that some at least of these sac-like projections are only temporary extensions produced by internal pressure. This was decided beyond a doubt by a series of continued observations upon single individuals, one of which, while swallowing a thread, was seen to assume successively the forms represented in figures 20 to 23, and another one while disgorging a thread changed shape as shown in figs. 24 to 31.

The substance of which these animals are composed is much like that composing the bodies of the various species of Amoeba, being soft, colorless, elastic and extensible. It is probably without any true integument, and is colored yellow by tincture of iodine. It appears to resist internal pressure with considerable force, and it is but rarely that it appears to be completely broken through by any of the matters, however hard, which are contained within it. I have however found some individuals, as represented in fig. 32, which had voluntarily impaled themselves upon long fibres which were distinctly seen projecting through the animalcules at each end, and these animals were seen moving freely along from one end of the fibre to the other without appearing to experience any inconvenience from the perforation. I have occasionally found them attached in this way to filaments of Conferva and Draparnaldia, which were still alive at one extremity. The traces of internal structure or organization are exceedingly slight. Occasionally, when a portion of the body is left vacant, some slender thread-like lines may be seen in the interior, as shown at *a* in fig. 40.

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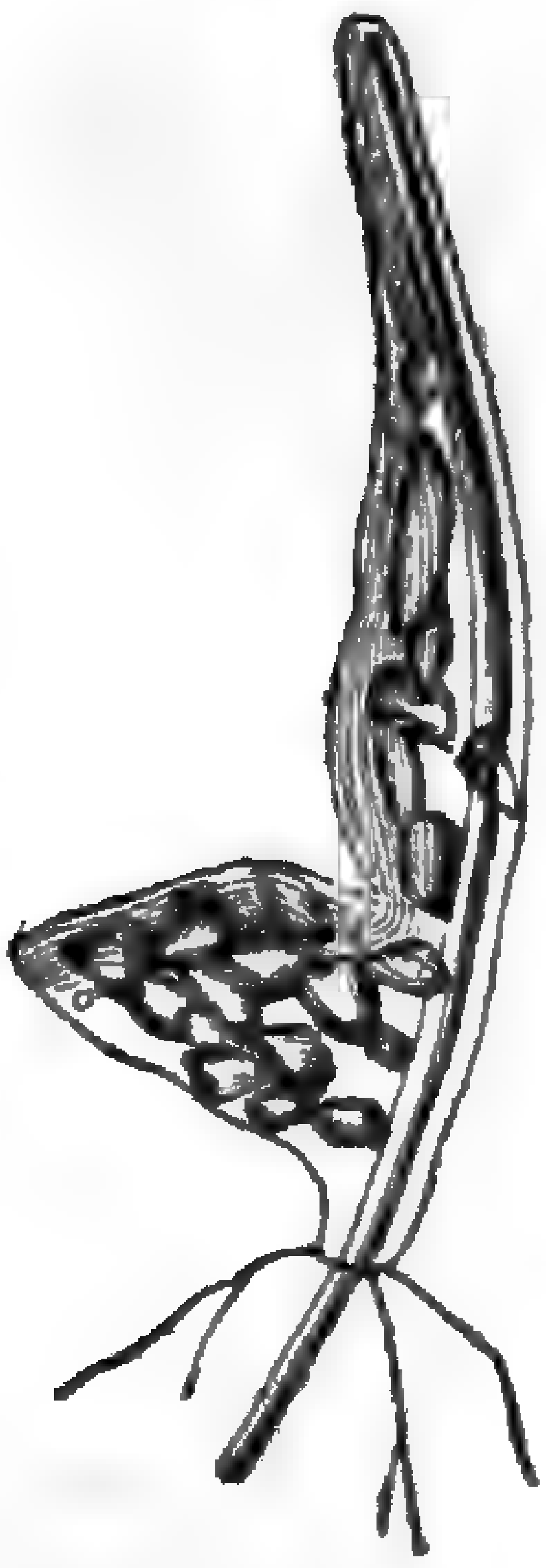

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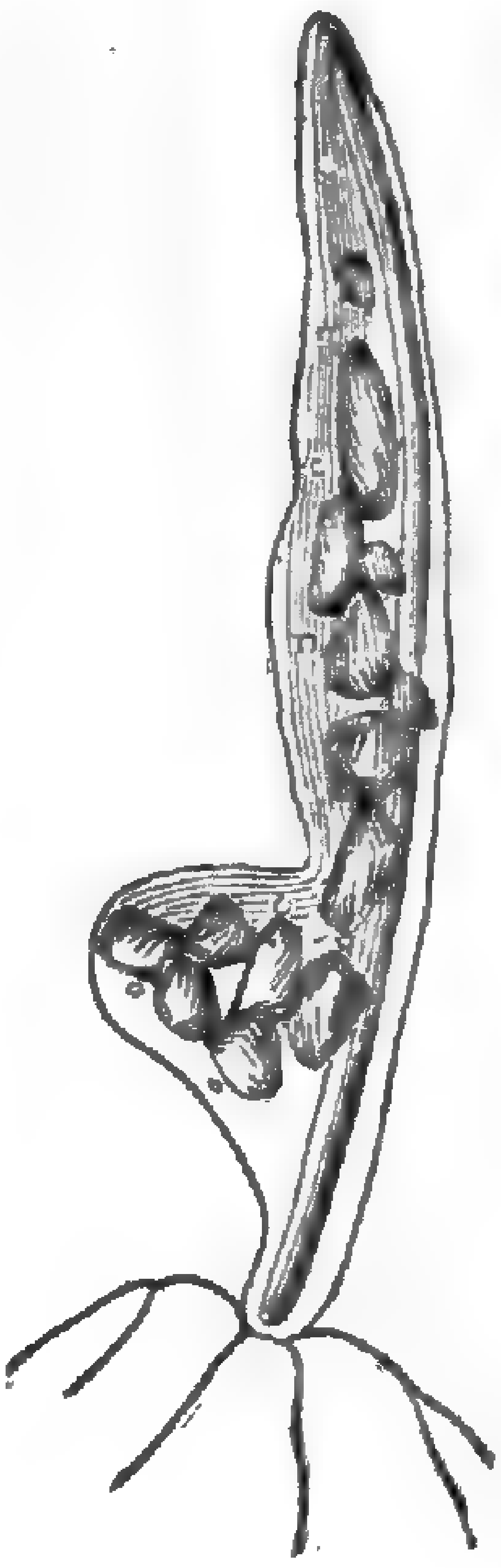

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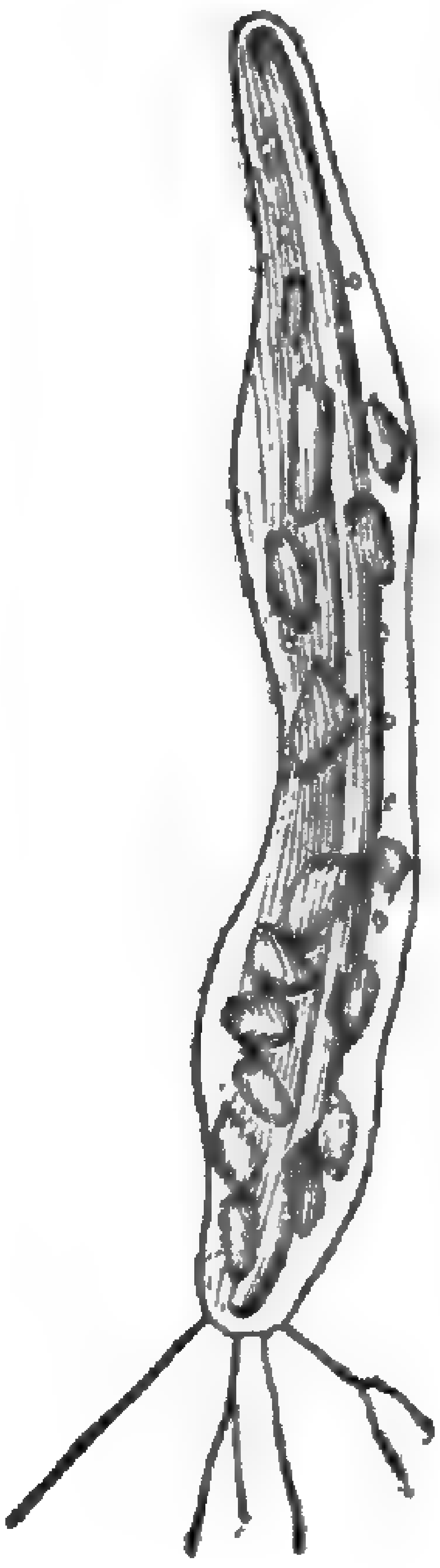

23.

In many individuals, (see fig. 33,) I have seen the protrusion from the mouth of transparent rounded masses, which rapidly succeeded each other until they were heaped up about the mouth like a set of soap bubbles and were then as rapidly drawn in again. The more common appearance however is that shown in most of the figures in these pages, where the mouth is surrounded by a considerable number of slender, colorless, radiant, branching, and retractile feelers, precisely like the rhizopods belonging to the marine Foraminifera or Polythalamia. When fully extended, these often exceed in length that of the body of the animal. They change rapidly from simple to branched, or vice versa, and are at one moment seen in a state of tension, fig. 34, and then wrinkled and collapsed, as in figs. 35 and 36, or changed into various rounded processes (as in figs. 37 to 39) which can be wholly retracted. In figs. 34 to 39 are shown some of these changes which were seen to take place in succession upon a single tentacle. These feelers, tentacles, variable processes or rhizopods are not like the pseudopods of Amoeba, mere protrusions of the surface, nor are they thrown out as in that genus from all parts of the animal. They on the contrary resemble those of a Difflugia in being confined to the vicinity of

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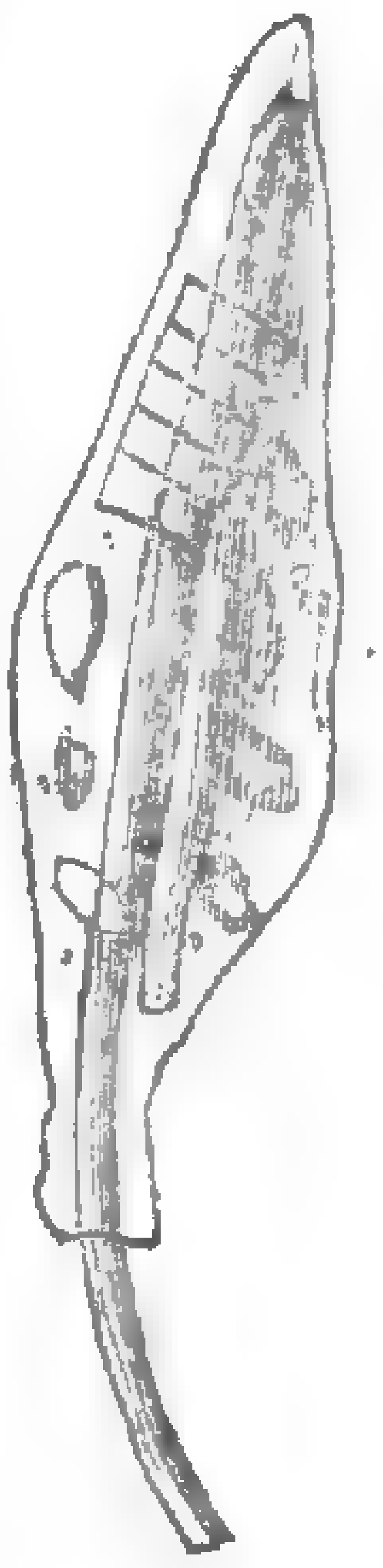

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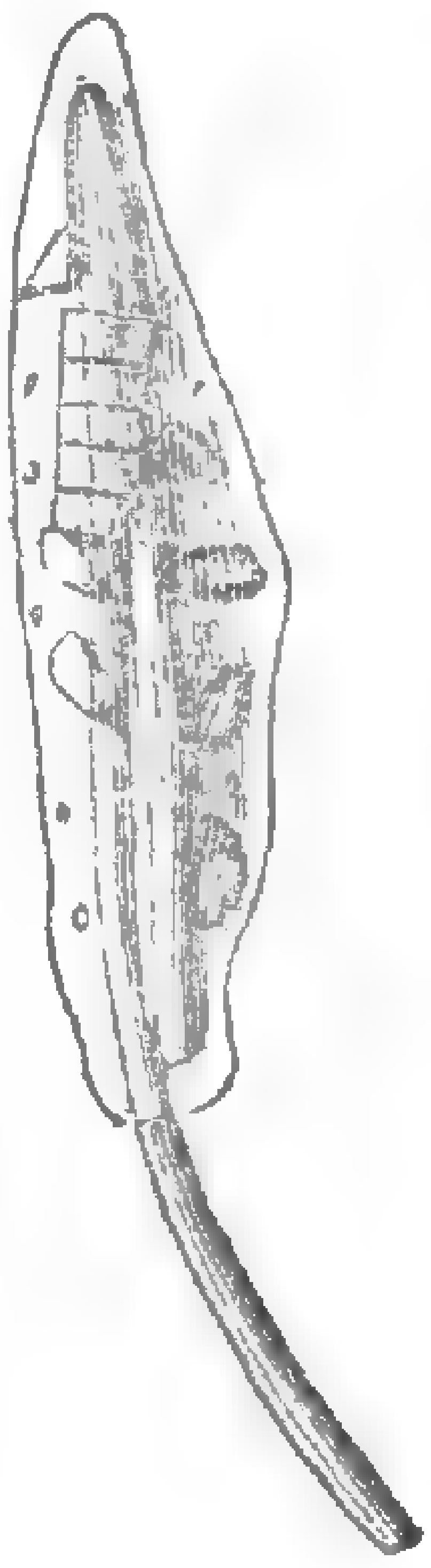

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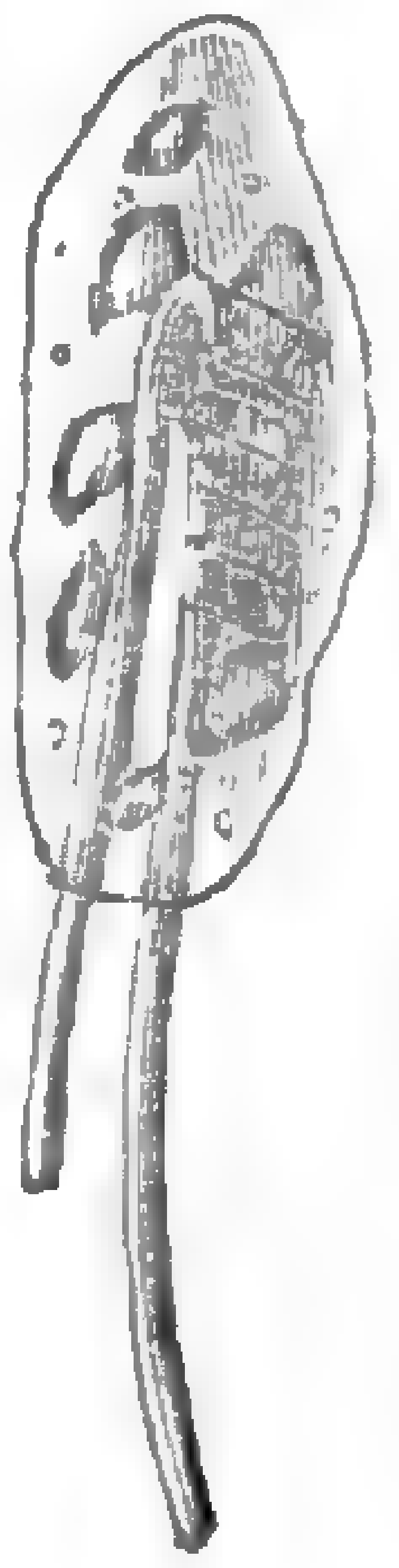

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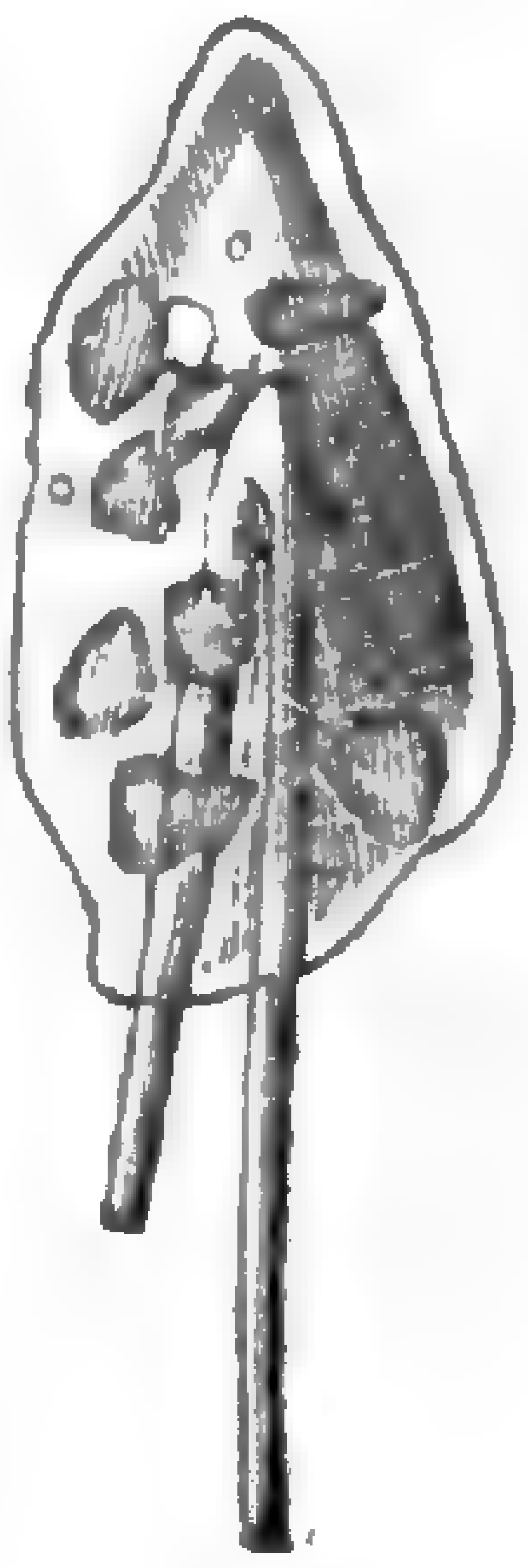

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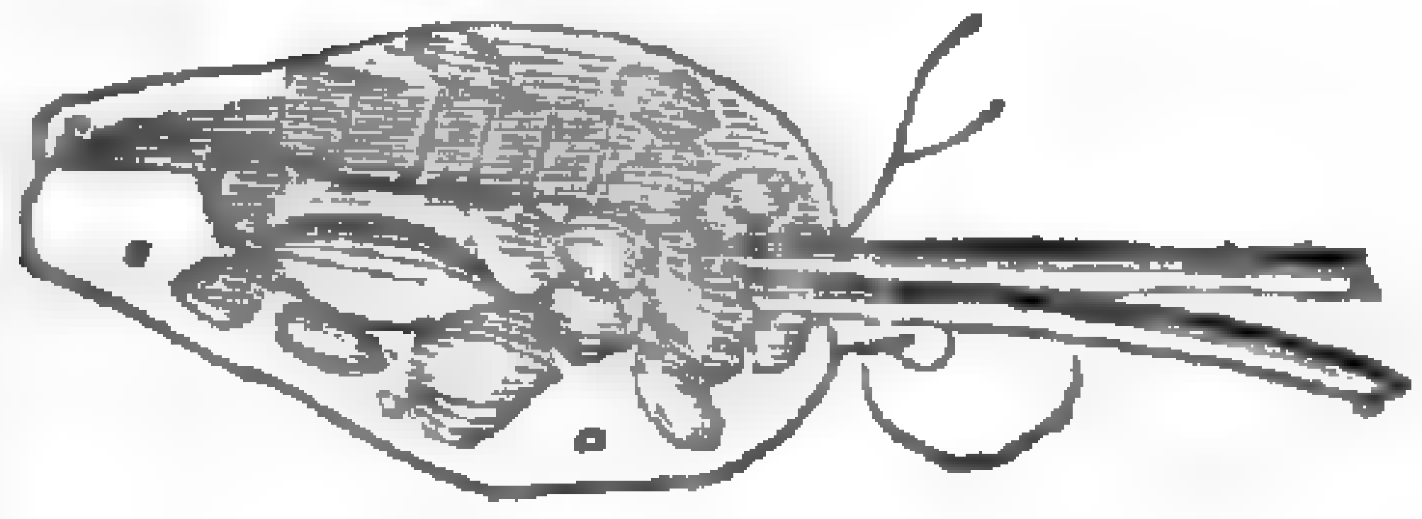

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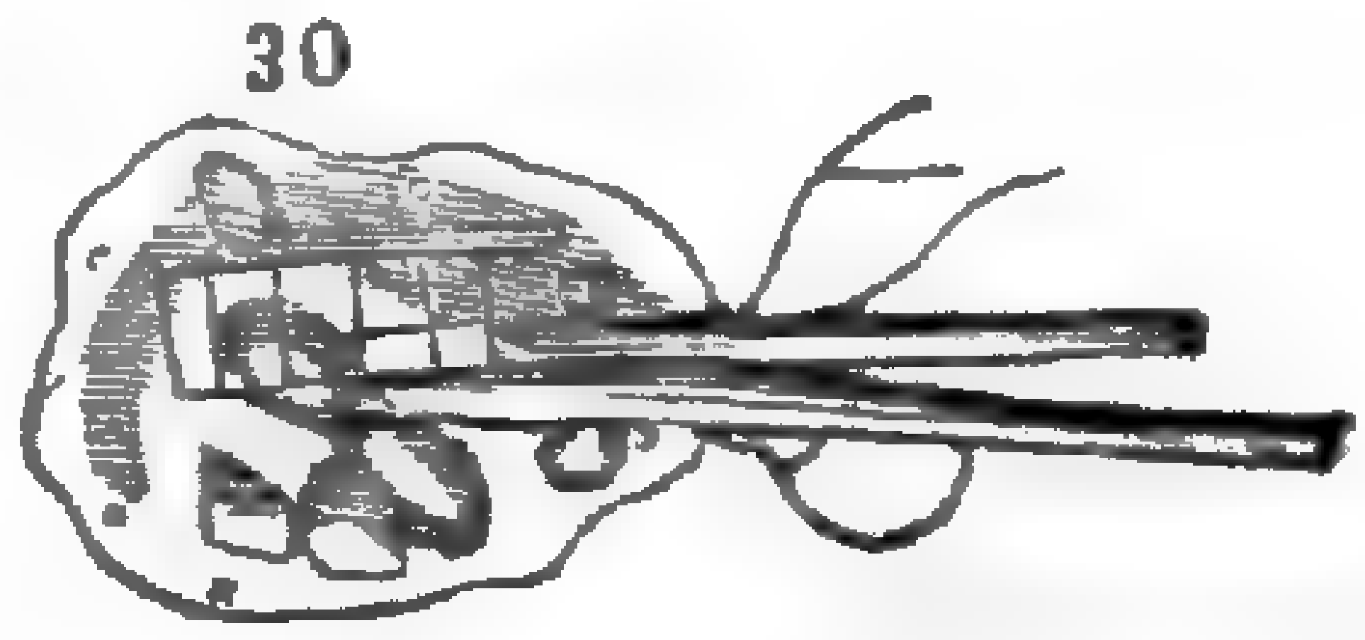

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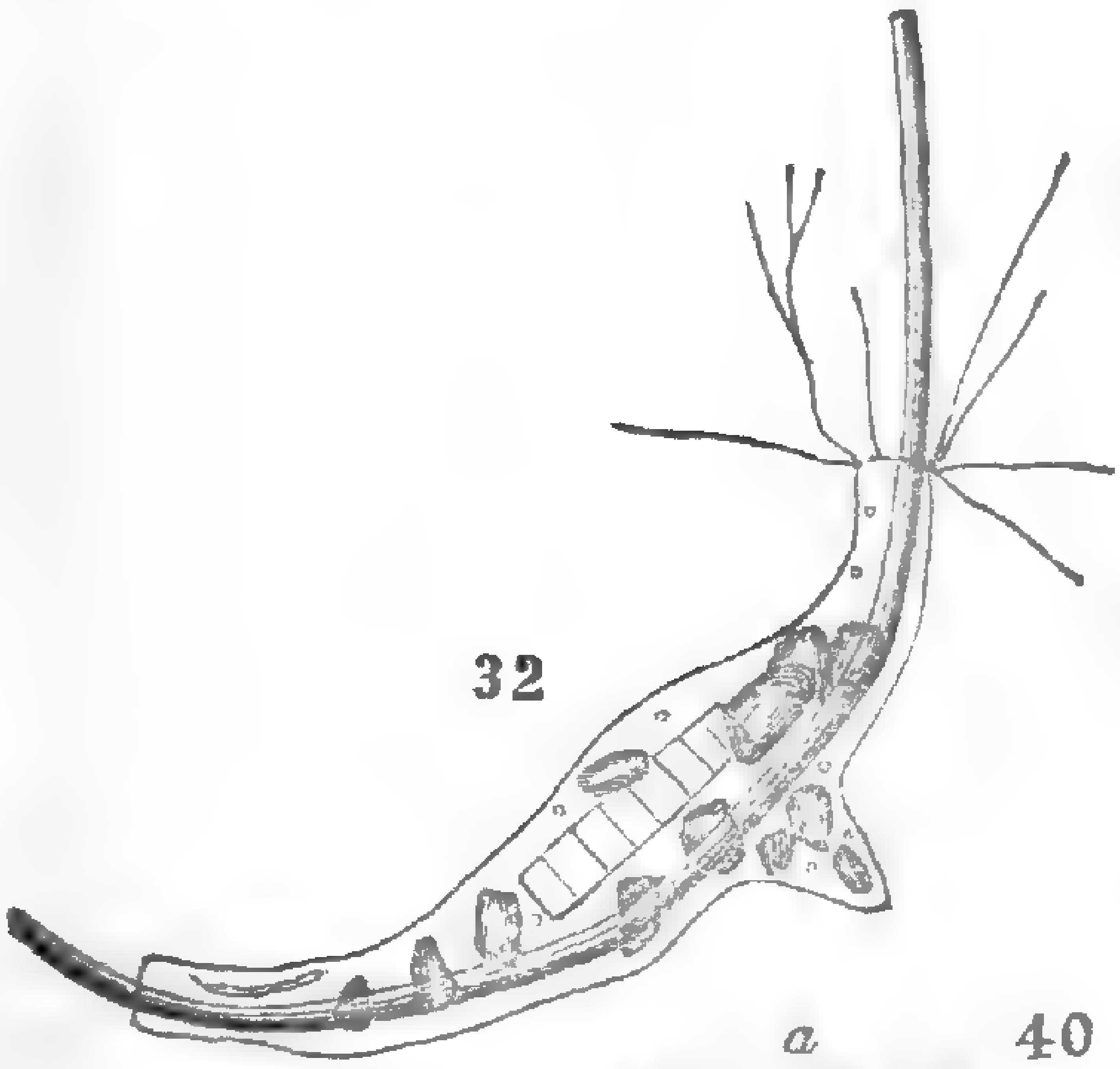

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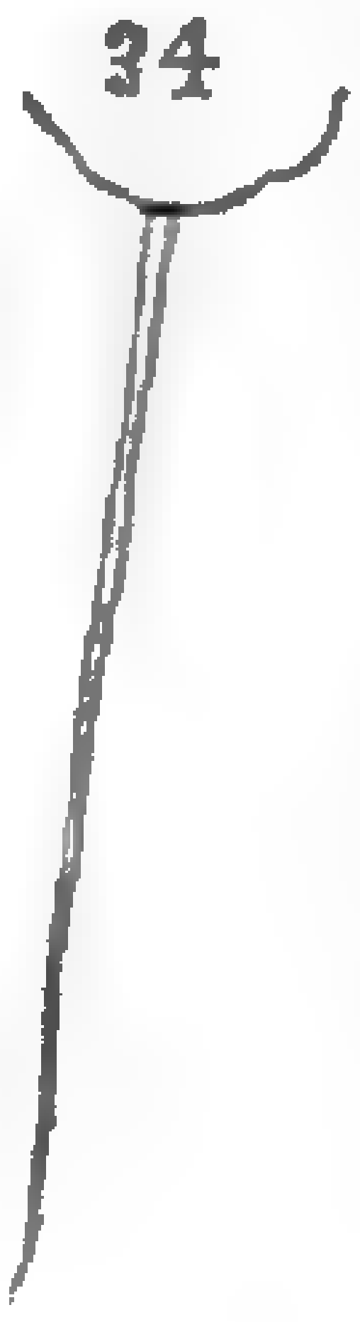

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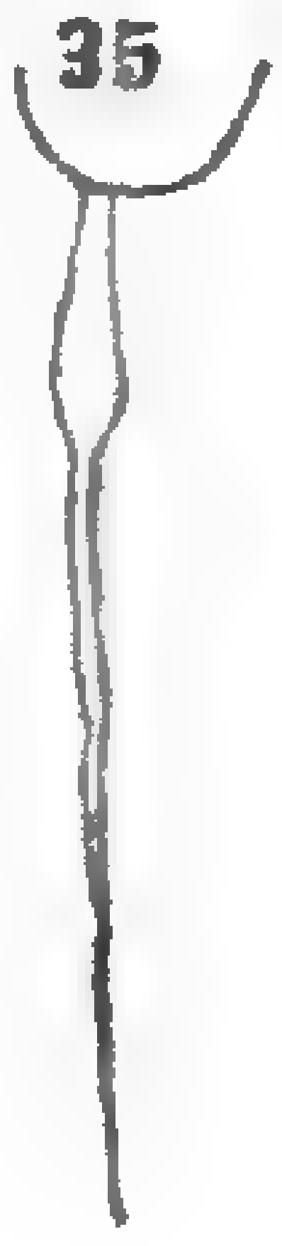

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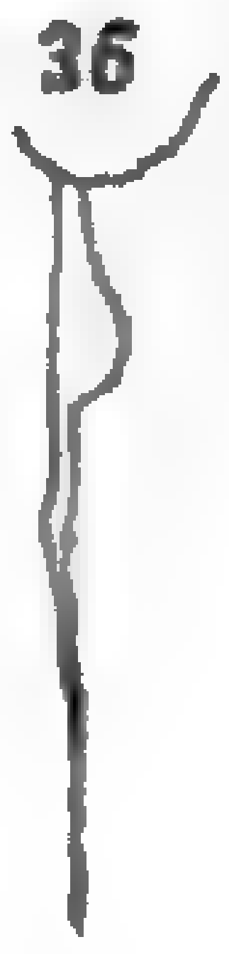

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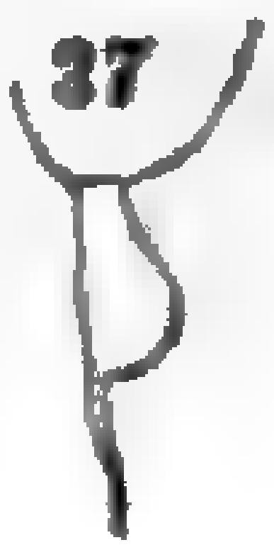

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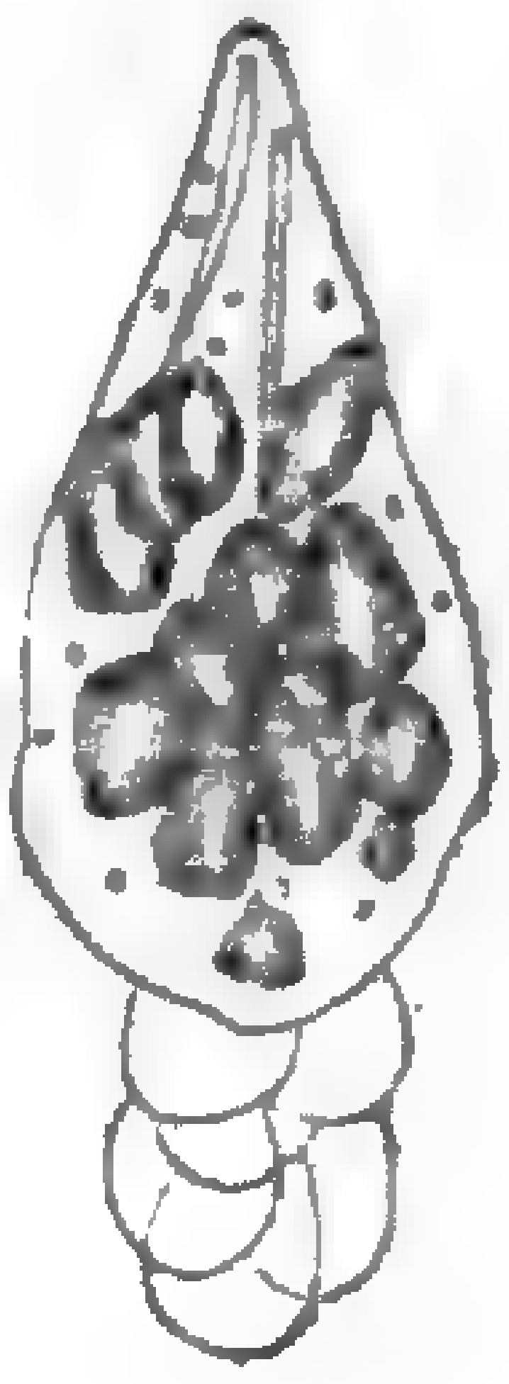

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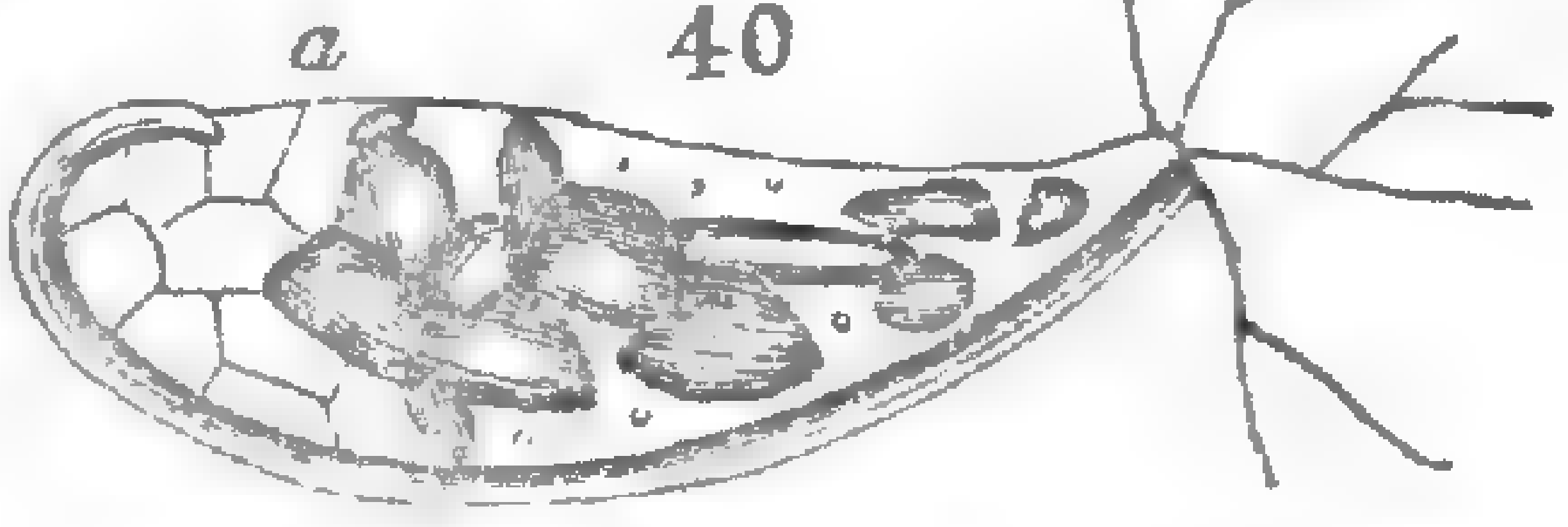

the mouth; but they are much more slender and more repeatedly branched than in any Difflugia which I have seen. By means of these organs the animals pull themselves along, when lying upon their side, and they also creep by means of them, with the mouth downwards, moving onwards with a slow gliding motion like that of a Difflugia.

Besides the heterogeneous collection of matters which these animals swallow, and which can be seen distinctly with all the forms and colors through the transparent exterior, there is also in most specimens a considerable number of small globules scattered without order, whose nature is very doubtful, for as yet there is no proof whether they are ova, oil drops, or something else.

When these creatures have swallowed bits of fibres which have been dyed of various colors, the reds, blues, scarlets, &c. of these filaments may be distinctly perceived through the sides of the animal, but the spectacle becomes still more curious when seen by polarized light, when the particles of quartz, &c. contained within these creatures also display their gorgeous tints.

When these creatures are dried upon glass, and then mounted in balsam, their forms are not greatly altered, and their contents become still more distinctly visible. It seems scarcely probable that these animals have so little discrimination as to swallow for food all the strange mixtures of organic and inorganic bodies which are found within them. It is possible, however, that adhering to these grains of sand, fibres of wool, &c., there may be nutritive matters deposited from the water, which may be removed by the process of digestion, as the soft contents of the shells of Diatomaceæ also appear to be. This view is supported by the fact that on the application of tincture of iodine to these animals, a distinct blue color was often seen all over the surface of many of the grains of sand in their stomach. The starch giving rise to this color was doubtless derived from bits of boiled beans and potatoes which had occasionally been introduced into the aquarium as food for other animalcules. Another fact which appears to show that the sand, &c. is not swallowed merely to increase the absorbing surface, as Dujardin suggests may be the case in Amoeba, is that these particles of sand are not retained for any great length of time, but in company with the empty shells of Diatomaceæ, and other remains of their food, they are after a while thrown out at the mouth, which appears to be the only aperture for their reception and discharge. There appears to be no reason to doubt that the cavity into which all these bodies are received, is a true stomach, and they therefore manifestly cannot be considered as polygastric animals. As to the position of these creatures in the system of Zoology, it is evident that they belong to the Infusorial Rhizopoda of Dujardin, and connect the genus Amoeba with Difflugia, agreeing with the first in the soft body without shell, but differing in having true feelers or rhizopods confined to the anterior portion of their body, and by not throwing pseudopods from other parts. From Difflugia and the whole family of Arcellina, these forms are distinguished by having no lorica or shell. They are, however, closely allied to the Arcellina, and are very nearly what some of the species of this group would be, if deprived of their rigid external coverings.

In order to give to these curious beings at least a temporary name and place, I propose to found for their reception a new genus named and characterized as follows, viz:

PAMPHAGUS, nov. gen.

Animals of the class of Rhizopoda (intermediate between Amoeba and Arcellina) without shell or lorica, and composed of a soft colorless matter easily extended by internal pressure, but not spontaneously protruded into pseudopods. Feelers or rhizopods, slender, numerous, radiant, branching and confined to the neighborhood of the mouth.

Species 1. *Pamphagus mutabilis.*—This species, which is the only one now known, is sufficiently described above. Its habitat is probably the bottom of small pools and streams of fresh water, as it was found in vast numbers in an aquarium supplied from such places in the vicinity of West Point. It will probably be found to be a common form, and as it presents the conditions of animal life in almost the lowest degree of simplicity, and can be preserved and studied with great ease, it will well reward the attention of microscopists. I have thousands of these animals now living in mid-winter, and with a little care they may probably be kept until the return of warm weather, when other interesting facts may possibly be added to the observations here recorded. The sketches above given, except figs. 34 to 39 inclusive, are all drawn to the scale on page 341, which shows ten one-thousandths of an inch equally magnified with the drawings. These sketches were all made by means of a camera lucida eye-piece attached to the microscope. The objective employed in making these drawings was a new one of surpassing excellence, of ½ inch focal distance, made by Spencer.

West Point, N. Y., Jan. 14, 1853.

ART. XXXIX.—*A Consideration of some of the Phenomena and Laws of Sound, and their application in the Construction of Buildings designed especially for Musical Effect;* by J. B. UPHAM, M.D., Boston.

(Continued from p. 226.)

WE have treated of reflection and echo, in their relation to our subject, in a preceding number of this Journal. Intimately connected with, and yet distinct in some points from these attributes of sound, is reverberation. By it we understand that prolongation of the sound in buildings, as if it were rolled about long after the original impulse and its ordinary reflections have ceased. This seems to us to consist of the *residuary* sound, or that portion of the sonorous wave which is neither absorbed nor reflected, but which, adhering to the walls of a room, is rolled along their surface till it gradually dies away. The action of light impinging against a wall, under certain conditions, will, perhaps, aid us to understand this. When a ray of light is incident on the surface of any transparent, uncrystallized medium, a portion of it is reflected, another portion of it is absorbed, and the remaining part is *dispersed* in all directions, and serves to render the surface visible.

Just so it would appear to be in the case of sound impinging against any plane surface. From this hypothesis we should infer that rounded corners and arched ceilings would facilitate the progress and keep up the prolongation of this residuary portion. Such conditions we find *are* actually favorable to the greatest amount of reverberation; and what is stronger proof of the truth of our position, it takes place, oftentimes, in an apartment too small for the injurious effect of direct reflection. A striking case in point is found in the arched recitation rooms of Girard College in Philadelphia. These rooms, eight in number, are fifty feet square in the clear, and twenty-five feet high, with solid walls, smoothly finished, and an arched ceiling extending over each in the form of a dome. We visited these rooms in 1846, while the college was in process of construction, and then ventured the prediction that they could never be made to serve the purposes for which they were intended, unless altered from their original form, owing to the excessive amount of reverberation engendered. This was found to be practically true, and measures have since been adopted to remedy the difficulty. In their original naked state, the prolongation of the sound in these rooms continued fully six seconds.*

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* It is but justice to state here that the consequences of this mode of construction were fully appreciated by the architect, Mr. Walter. In his final report, speak-

On re-visiting the College the present season, and repeating our experiments in these rooms, we found the effect of the remedial measures adopted to be remarkably striking. In one room, which had been treated simply by papering upon the solid walls and extending festoons of cotton cloth from the apex of the dome to the corners and centre of the cornices in each side, the reverberation was reduced to four and a half seconds; and in others, in which a partition of cloth was stretched across the room horizontally, from the opposite cornices, thus completely shutting off the arched ceiling of stone, and substituting a level surface of yielding canvas, its duration was only half a second. By whose suggestion these simple contrivances were tried, we could not learn, but presume they originated with the skillful architect of the building.

Another argument that such is the nature of reverberation, is derived from the fact that those apartments found to possess the quality of a whispering gallery, (which is generally explained on the principle of the conduction of sound along the surface of the walls and ceiling,) are always domed or of ellipsoidal shape, and they are those in which the reverberation is also greatest. Among the most celebrated of these is that of St. Paul's Cathedral, (a circular and domed apartment about one hundred and twenty feet in diameter,) in which a whisper is conveyed two or three hundred feet. The shutting of a door produces a rumbling like distant thunder. The rotunda of the Capitol at Washington is ninety-six feet in diameter and ninety-six feet high, the dome of which is a fine whispering gallery. The reverberation in this apartment is such as wholly to destroy the articulation of the voice at a slight distance. The principal room of the Merchants' Exchange in New York is of a similar character. When, as is often the case, an auction is being carried on in some part of it, it is utterly impossible to distinguish the words of the speaker at more than a few yards distance. In the vestibule of Girard College, which extends upward the whole height of the building, having two wings, each surmounted by a dome, a powerful and shrill note of the voice is prolonged more than ten seconds after the original sound has ceased. In the vestibule of the Boston Atheneum, which is similarly constructed, with but one wing however, the reverberation is four and a half to five seconds.

The recollections of a visit to Weyer's Cave in Virginia, in the summer of 1843, are still fresh in memory. The principal apartment here (called Washington's Hall) is two hundred and

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ing in reference to the excessive reverberation of these rooms, he says: "They are, however, constructed in exact accordance with the will, and these results were anticipated in the earliest stages of the work; but as Mr. Girard left no discretionary power in reference to this part of the design, we were compelled to take the letter of the will as our guide, let the results be what they might."

seventy feet long by from twenty to thirty broad, and fifty feet high. Says an enthusiastic writer, in describing this apartment:

> "The curious explorer now witnesses something amazingly sublime. The walls are strung with musical colums which, by moving a stick over them, will produce a confusion of discordant sounds. The drum, the tamborine, the organ, are each represented and their notes, discordant heard alone, together aid the full concert, while the sound-board roars its melancholy murmur through the whole. But to attempt to describe what is here seen and felt is quite in vain; nor can any person form even the faintest idea of the sublimity and grandeur of this subterranean abode until he witnesses its magnificence, nor then can he find language copious enough to express his emotions."

This is no exaggeration. As is well known, this cave is formed in calcareous rock, and abounds in huge, irregular, and grotesque apartments, extending out, in every direction, into recesses and galleries, and crowned with lofty domes and inverted spires. In almost every part of the cavern, sounds of medium loudness are multiplied, prolonged and intensified to a degree that is absolutely terrific. But a few days subsequent to our visit, this cave was illuminated by two thousand lamps, and a band of music made to perform in one of its most resounding portions. Much have we regretted since, that it was not our fortune to be present on so unique and sublime an occasion. To the eye, the effect must have been indescribably grand, while, to the ear, as we can readily conceive, such commingling and prolongation of successive sounds, though in themselves musical, would bring one vast and overwhelming discord, which could be likened only to the fabled bellowing of the mountains in agony.

> "Hic vasto rex Æolus antro
> Luctantes ventos tempestatesque sonoras
> Imperio premit, ac vinclis et carcere frenat.
> Illi indignantes magno cum murmure montis
> Circum claustra fremunt."

Some experiments made by the writer in the main apartment of the Boston Music Hall, while its interior was undergoing the various stages of finishing, are, in this connection, both interesting and important. This room is 130 feet in length, by 78 in width, and 65 feet high. After the floor had been laid, and the walls and ceiling furred off and lathed all around, preparatory to the reception of the plaster, the amount of reverberation was found to be inconsiderable, while a good degree of resonance was furnished by the solid masonry which formed the main body of the walls. The operation of plastering was done with despatch; and while in its recent state, being roughly finished and still soft and moist, the reverberation of the hall was at its minimum, and its resonance at the same time almost wholly gone. Heard under these conditions, the articulations of the voice were exact and distinct, but there was an absolute *deadness* to its tones necessitating the greatest effort on the part of the speaker, so much did the sound seem to be swallowed up by the soft coat which completely enveloped it. The effect was literally that of a wet blanket thrown over both speaker and hearer. Day after day, as the layer of plaster hardened and dried out, both the resonant and reverberatory qualities of the room returned with increasing intensity. There was a period when it seemed as if these two properties (always to some extent antagonistical) were satisfactorily balanced, the former being sufficiently strong, while the latter was not unduly prominent. But such a state of things was of transient duration. When the composition upon the walls and ceiling was made smooth, and had become completely hardened, reverberation was very much in the ascendant, though still, in a measure, checked by the staging which filled up the interior of the hall like a forest of masts. On the removal of the staging, a powerful tone of the voice was prolonged four to four and a half seconds. This was when the room was empty, and completely devoid of upholstery and carpeting. When the floor of the main hall and balconies was covered with benches, having cushioned seats and backs, the aisles carpeted and the semi-circular windows near the ceiling shielded with curtains of canvas, the change was very marked, and the presence of a moderately large audience so completed the cure as that no injurious excess of sound remained. Should it be required, on any occasion, to reduce still further this reverberatory property, it can (in the opinion of the writer) be readily and perfectly accomplished by the use of additional upholstery, and the adoption of a simple contrivance with canvas, placed against the walls just below the cornice, which would not appreciably interfere with the resonance of the room, nor mar, to any extent, its architectural beauty.*

Mr. J. Scott Russell, whose opinion, in almost all matters of scientific enquiry, is entitled to profound respect, has adopted a different view of the nature of reflection and reverberation from that here expressed. In a discussion upon this subject at a meeting of the Royal Institute of British Architects in March, 1847, Mr. Russell contended that, contrary to the generally received notion of sound being reflected in a manner the same as light, it is

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* The writer has recently been consulted with reference to the acoustic defects of the new Town Hall in Weymouth, Mass. The size of this hall is about 80 feet by 56, and 28 feet in height. It has perfectly smooth walls and ceiling. There are three windows on each side. It has no drapery or upholstery whatever. The reverberation is represented to be so great as to render the building wholly unfit for the purposes for which it was intended. Some measures were recommended for its improvement, the success of which remains to be seen.

The reverberation in St. Paul's Church, Boston, which is usually very considerable, is so checked by the customary decorations of the Christmas season, that the utterance of the speaker is then much more distinct than at other times.

thus reflected from a plane surface, only when the angle of incidence is greater than forty-five degrees, whereas, if the sonorous wave is incident on a surface at an angle less than forty-five degrees, it suffers little or no reflection, but is moved along in close proximity to the plane against which it is projected, and thus gives rise to the phenomena of reverberation. Mr. Russell derives from these supposed facts some practical suggestions, which he deems important in the construction of buildings intended for public speaking. Such rooms, he contends, should be so arranged as to avoid, as far as possible, all surfaces at right angles to the direction of the sound, and substitute those in which the incidental angle shall be less than forty-five degrees. Those surfaces, he continues, which must, of necessity, be at right angles to the sound, should be as far distant as possible. He suggests, also that in large rooms of quadrangular shape, the speaker, to be heard distinctly, should place himself near one corner, and direct his voice diagonally across to the opposite corner: that it is better, as a general thing, to speak from a point near a wall or pillars than from a distant point; and that, in a room of common form, it is better to speak along its length than across it. These maxims he lays down in order to avoid (on his theory) the undue reflection of sound. To check reverberation he enjoins the use of pilasters, placed at frequent intervals along the sides of the room, that the impulses, which strike the wall at an angle less than forty-five degrees and traverse its surface, may thus be broken up and destroyed, as waves moving upon water are arrested and broken up by the projecting posts of a pier.*

Mr. Russell further says that, though, in his own mind, he is convinced the action of sound, in these particulars, is in accordance with the manner just stated, he can offer no philosophical explanation of the facts. A writer in an English Journal, however, has offered the explanation of Mr. Russel's theory, which he himself declined to undertake. But, as the reasoner grounds his argument upon the assumption, at the outset, that the wave of sound may be considered a force of *continuous progression*, while such is not the case with a ray or wave of light, (a difference, the existence of which we must deny in toto,) we will not delay, in this connection, to follow out and refute his reasoning.

It is satisfactory to us, that the doctrines we have adopted in regard to reflection and reverberation of sound are strong in their analogy to the known laws of light, in its similar phenomena; and, while on this ground, we can equally well explain the more important maxims deduced by Mr. Russell, we will not, now, seek to disturb those harmonious relations of sound with light,

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* The walls of the Boston Music Hall are thus treated, and the ceiling is deeply pannelled.

that we have found to exist, in so many other respects, between these two mysterious and all-pervading elements in nature.

Hitherto our attention has been directed mostly to the facts and principles which we conceived to be connected, more or less intimately, with the question at issue. We come now to the practical application of these facts and principles in the architecture of a building designed especially for musical effect.

Doubtless the conditions most favorable for the distinct perception and full appreciation of music, are to be found in the free air, where the medium through which the sound passes is without admixture, and nothing interposes or bounds, to alloy the purity of tone, to absorb, interrupt or dissipate the sonorous waves, or throw back upon the ear the disturbing influences of reflection or reverberation. There is no sublimer sound than the mingling of a thousand voices and instruments in an open field; so, on the surface of a lake, in a calm evening, music will seem to fill the air with a distinctness of utterance, and melt upon the ear with a delicacy, not elsewhere found. Handel knew this when he contrived his celebrated water music to gratify his sovereign, George I, whose anger he had incurred. But, in the nature of things, especially with a climate like ours, it is rare that music can be thus worshipped at her own shrine. Moreover the sensitiveness of many of the instruments which compose the orchestra at the present day, forbids their ever being used without injury in the open air.

In the construction of a Concert Room, therefore, our efforts should be directed to overcome, as far as possible, the imperfections to which every musical performance is necessarily subjected when confined within the four walls of a building. Theoretically, could we secure the ready passage and equal diffusion of sound over the whole apartment, without the intervention of reverberation or disturbing echoes, we should have a *perfect* Music Room, in every part of which the auditor would hear with equal distinctness and accuracy. How to approximate to this is the problem that here demands our serious attention.

In the discussion of this question, we shall consider the subject with reference to the following particulars, viz: Position, Shape, Proportion, Size or Capacity, Nature of Materials used and Mode of Construction for the walls and ceiling, Ventilation, Warming and Lighting, together with the details of the interior of the structure, so far as relates to the form and finish of its principal parts.

It seems almost superfluous, in this connection, to allude to the necessity of a retired position or other measures to exclude external sound, as an important requisite of a Concert Room. But these are points hitherto much neglected.

In every large city the multitudinous cries and sounds of busy life produce a constant discord, which the spirit of music seeks to avoid. Much of the difficulty and annoyance complained of in the old House of Commons buildings, resulted from this cause alone.

The *site*, therefore of every building intended for musical purposes should be such as to exclude, as far as possible, all access to these external sounds, whether by direct communication or by conduction. If position alone will not secure this desideratum, much can be done, in aid of the object, by the proper construction of the building itself. It is advantageous, on this account, to have corridors extending completely round the room, thus cutting off all direct communication from without. Double walls and windows are also very efficacious in excluding noise. The number and position of the windows and doors is, likewise, important.

Attention to this particular is necessary, also, in the arrangement of the apertures for the admission of cold air from without for purposes of ventilation, as well as in the methods adopted for the escape of vitiated air, the product of respiration and combustion. In no case should these openings communicate directly with a noisy street or vicinity. Dr. D. B. Reid suggests,* when such connection is unavoidable, that all these openings be arranged in such a manner that while air is freely permitted to enter or to escape, the sound will have to be several times reflected in its passage, and thus be stifled or destroyed.

The proper *form* or *shape* of a room intended for sound has been a subject of much dispute.

On this point, the evidence of the witnesses examined by the Committee of the House of Commons is at variance. But in the case of the apartments in the Commons Buildings, submitted to the judgment of so many eminent architects and scientific men, there were peculiar difficulties to be overcome, resulting from Parliamentary habits of debate. There, as in our own Legislative Halls, the members speak from their places, and the speaker is an ever varying object with reference to the audience. It was required, therefore, to produce a room from every point in which a speaker could be heard with equal facility in all other parts. This it was that most seriously embarrassed the plans of all the architects summoned, and is sufficient to account for the great diversity of opinions expressed. In this form, indeed, it seems to us a problem incapable of being solved by any of the known principles of science. In a music room, fortunately, we have to deal with sounds which originate in but one portion of the apartment, and which are, therefore, far more within our control.

As to shape, the circular, the quadrate, the oblong, have all found their advocates. The principal argument in favor of a

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* Reid's Illustrations of Ventilation; Art. Communication of Sound.

circular form is drawn from the fact that all the ancient theatres, Greek and Roman, are so constructed; the conclusion being that, had not this been peculiarly favorable to hearing, it would not have been so generally adopted. But, however much the Greeks and Romans excelled in their dramatic representations, and in the arts of eloquence and oratory, they knew little or nothing of music, as at present understood, and the use of the ancient theatre would ill comport with the requirements of a modern concert room. Both the player and the orator, in great part appealed to the eye in aid of the intended effect, while the ear unaided takes cognizance of music. In a large concourse, the circle, doubtless, combines more advantages for seeing than any other. But for distinct hearing the case is far different. For the reasons stated in the preceding pages, such conformation in the walls of a building is especially liable to reverberation or the prolongation of the residuary sound, an effect which is fatal to distinct hearing, and more than anything else, perhaps, mars the excellence of a musical performance. On the same principle we must reject the semi-circle, the oval, ellipse, and all other modifications of the circular form. So, also, should arched ceilings, rounded corners, domes, concavities and all curvilinear forms, in whatever part of the room, be discarded, as much as possible, as tending to augment the reverberatory power, and as having the effect, moreover, to collect and throw the sound in masses in different points, instead of allowing its equal diffusion throughout the whole apartment.

On the authority of the Rt. Hon. J. W. Croker, in his evidence before the House of Commons Committee appointed in 1833, the new Chamber of Deputies in Paris is sadly defective in its acoustic qualities. This room is semi-circular, having a chord-line of ninety-six feet, and is covered by a flatly domed ceiling. Said Mr. Croker, in reference to this apartment, "being doubtful whether it was not some defect in my own hearing, I made enquiries of several members, who confirmed my opinions of its being a very bad hearing house." He also makes similar complaints of the Irish House of Commons, which is a circle of about fifty-five feet, surmounted by a high spherical dome.

The quadrangular form is not liable to the objections above stated, but there is a greater lateral expansion and consequent loss of sound in a square room than in one of the same area whose length is greater than its width; hence, in a room of a parallelogram shape, a given sound will be conveyed to all parts of it with greater force than in the former case.

It is considered by many that, in a *small* room, the shape is of little or no consequence, as regards the sound, inasmuch as the ear, (say they,) cannot appreciate its defects. This is, no doubt, true in a room whose greatest diameter does not exceed fifty-five feet, so far as direct reflection is concerned; but, as we have already observed, in the case of the recitation rooms at Girard College, which come inside of these measurements, the *reverberation* may yet be very great.

The Melodeon at Boston is imperfectly ellipsoidal in shape, with smooth walls and ceilings. Its length, width and height are, respectively, 113½, 57 and 35 feet. In the centre of the ceiling, which is flat, is an immense dome whose diameter at the opening is thirty-three feet. When moderately filled, as at the Musical Fund Society's rehearsals, the reverberation, as we have found by repeated experiments, is from two to two and a half seconds, a condition which is fatal to the distinct utterance of passages in music of even moderate rapidity.

The three most successful concert rooms in England are rectangular and oblong in figure, with rectilineal walls, joined by a coving of moderate extent to a flat ceiling.

The *proportions*, as well as the form of a music room, are not a matter of indifference. We have already noticed the tendency of one vibrating body or medium to throw another, in contact or in its immediate vicinity, into a similar state of vibration. In this way the oscillations of the contained air of a room, communicated to its walls, produce therein a sympathetic vibration, which will be more or less perfect according as the structure of these walls, their subdivisions and general relations of length, width and height, approximate to the acoustic conditions required. From this comes *resonance*, as we understand, the existence of which, to a considerable extent, in some rooms gives to the voice that peculiar brilliancy and resilient power which every singer must have noticed.

The experiments of M. Savart on the sonorous vibrations of solids are interesting in this connection, as showing the nature of resonance and how the original sound is thereby intensified, whether the resonant body is in actual contact with that producing the primary sound or not.* A ready illustration may be obtained by singing a note in the vicinity of a large drinking glass, and in the still more familiar experiment of speaking inside the mouth of a barrel. In both these cases the solid materials are put in vibration and impart a peculiar quality as well as intensity to the tone. Instances are on record where glasses have been broken in this way, by a powerful voice. To satisfy oneself that the vibrations are thus communicated in a well-constructed music room, it is only necessary to place the hand upon the walls during the performance of a symphony or chorus, and they may be felt.

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* Vide the Memoirs of M. Savart to the Royal Academy of Sciences of Paris, published in the *Annales de Chimie;* also Art. Sound, in *Encyc. Metrop.*, for copious extracts.

Mr. Gardiner long since suggested the observance of some definite form and proportions in the construction of music rooms. He recommended the figure of two cubes as a model. In this he derived his ideas from observation in the old cathedrals of Europe, which, he found, most approximated to this form, and among the finest music rooms in existence. More recently also, Mr. J. Scott Russell has advocated the use of aliquot parts of some common multiple, for the proportions, in length, width and height, of speaking and concert rooms, though upon what grounds we do not find distinctly stated.*

Our own belief is that we are to look for the explanation of these requirements simply to the phenomena exhibited in the vibration of musical strings and pipes.

Says Mr. Herschell:

> "A cord, although vibrating freely, may yet have any number of points equally distributed at aliquot parts of its whole length, which never leave the axis, and between which the vibrating portions are equal and similar. Such points of rest are called *nodes* or *nodal points;* the intermediate portions which vibrate are termed ventral segments."

See the subjoined figures, which are taken from the Encyclopedia Metropolitana.

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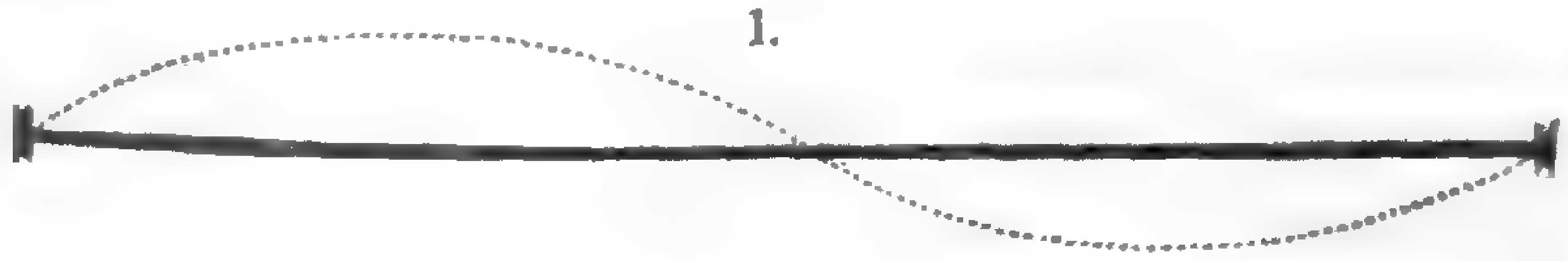

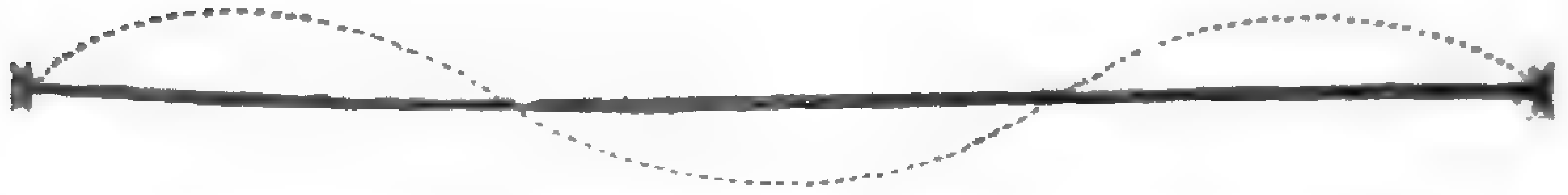

In illustration of the same point, he further says:

> "If the string of a violin or violoncello, while maintained in vibration by the action of the bow, be lightly touched with the finger, or a feather, exactly in the middle, or at one third of its length, it will not cease to vibrate, but its vibrations will be diminished in extent and increased in frequency, and a note will become audible, fainter but much more acute than the original, or as it is termed the fundamental note of the string, and corresponding in the former case to a double, in the latter to a triple rapidity of vibration. If a small piece of light paper, cut into the form of an inverted V, be set astride on the string, it will be violently agitated, and, probably, thrown off when placed in the middle of a ventral segment, while at a node it will ride quietly as if the string were (as it really is at those points) at perfect rest. The sounds thus produced are termed *harmonics.*"

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* The proportions of the Boston Music Hall, recently erected, are in accordance with Mr. Russell's views in this respect, being in length, width and height, respectively, 130, 78, and 65 feet.

But if a string, in the act of vibration, be touched at any other than these nodal points, its vibrations will be immediately confused and clogged. Precisely thus, in our view, is the case of the walls of an apartment. Here the whole extent of the wall, enclosing the four sides, may be regarded in the light of a vibrating string; and the angles of the wall should come in the points, required by the harmonic subdivision of the vibrating surface, which we have just seen must be placed at aliquot parts of its entire length. These angles would then mark the nodal points, or points of rest. And following out this reasoning, we would go still further and suggest that all the necessary breakages and interruptions by pillars, pilasters, doors and windows, should correspond with the nodal points in the wall, so as thus to interfere as little as possible with the free vibration of the whole, or its parts.

A room thus constructed will possess distinctly its key note, which every public speaker will find it to his comfort to seek out and regard.

But aside from these important considerations of position, shape, and proportions required in a structure of the kind proposed, *magnitude*, or a *large capacity* is indispensable to give to music its full power. The most sublime effects of the oratorio and symphony can only be produced in spacious buildings; this is independent of the number of the audience, and, in great measure, too, of the vocal and orchestral force employed. Mr. Gardiner was admitted to the rehearsal of the first grand performance in York Cathedral in 1825, when only five auditors were present. The choral and instrumental band consisted of six hundred performers. In one of his desultory volumes he thus speaks of that occasion:

> "Upon the first burst of the voices and instruments on the words 'Glory be to God,' the effect was more than the senses could bear, so much was the sound augmented by the vast space of this noble building; nor was it till those overpowering concussions ceased that the imagination could recover itself."

And in another place, referring to the same subject, he remarks:

> "Who has not observed the peculiar lustre imparted to a musical performance in a spacious church, which heard in other situations would give the ear no pleasure?"

Washington Irving, in his "Sketch Book," thus beautifully and with graphic power describes the effect of a sudden burst of music amid the vast silence of Westminster Abbey:

> "The sound of casual footsteps had ceased. I could only hear, now and then, the distant voice of the priest repeating the evening service, and the faint responses of the choir; these paused for a time, and all was hushed. The stillness, the desertion and obscurity that were grad-

ually prevailing around, gave a deeper and more solemn interest to the place. * * * * * * *

"Suddenly the notes of the deep laboring organ burst upon the ear, falling with doubled and redoubled intensity, and rolling, as it were, huge billows of sound. How well do their volume and grandeur accord with this mighty building. With what pomp do they swell through its vast vaults, and breathe their awful harmony through those caves of death and make the silent sepulchre vocal! And now they rise in triumphant acclamation, heaving higher and higher their accordant notes, and piling sound on sound. And now they pause, and the soft voices of the choir break out into sweet gushes of melody; they soar aloft, and warble along the roof, and seem to play about these lofty vaults like the pure airs of heaven. Again the pealing organ heaves its thrilling thunders, compressing air into music, and rolling it forth upon the soul. What long-drawn cadences! What solemn, sweeping concords! It grows more dense and powerful—it fills the vast pile, and seems to jar the very walls. And now it is winding up in full jubilee—it is rising from the earth to heaven—the very soul seems rapt away, and floating upwards on this swelling tide of harmony!"

The commemoration of Handel, which took place in Westminster Abbey in 1784, forms one of the grandest musical epochs in history. This festival lasted five days, and was conducted in presence of the Royal Family and many of the nobility of the realm, and the public in general to the number of three or four thousand persons. The number employed in the instrumental and choral band amounted to between five and six hundred. In 1834, just fifty years afterwards, this festival was repeated, and in an account of it, a writer in the *Musical Library* speaks as follows:

"The nave of the Abbey is 150 feet long, and, including the aisles, 72 feet wide; its height 101 feet. This space was converted into a grand saloon, at the west end of which was erected the orchestra, rising from about eight feet from the floor to the middle of the great window; the principal singers and the instrumental performers occupying the nave part: the chorus filling the portion in the aisles up to the tops of the arches. In each aisle was built a long deep gallery extending from the orchestra to the royal boxes, and projecting from the wall to about three feet beyond the columns. The galleries contained several rows of seats, rising to the key-stone of the arches. The aisles below were fitted up in a manner similar to the galleries.

It is admitted that the performers, on the present occasion, excelled in every way those who formed the orchestra on the different festivals at the close of the last century. The force employed in the full pieces amounted to five hundred and ninety-one; and the band generally, both instrumental and vocal, can only be mentioned in terms of the highest praise. Yet those who heard the music in York Cathedral, in 1825, declare that, with about the same number of performers, but *in an area more than double that of Westminster Abbey, the effect was greater than that just witnessed in the capital of the kingdom.*"

But we need not go so far away for evidence and illustration in proof of our position. Who among those present at the late opening festival of the Boston Music Hall could fail to notice the peculiar mellow effect of Handel's "Hallelujah," and "The Heavens are telling," though rendered by a force of fifty instruments and five hundred voices?

These effects, in the instances above mentioned, may be, in part, attributed to the associations of time and place, but in greater part, we contend, are they owing to the architectural qualities of the building. And the explanation is to be found, doubtless, in the fact before alluded to, that distance aids in fusing together and harmonizing musical sounds. Let any one, who is skeptical of this truth, but listen to a band of indifferent performers in the open air, on a summer's evening, first in close proximity to the players, and then at a distance, and he cannot fail to be convinced. It is the test of a good organ to throw out its sounds with fulness and opulence, into the body of a church, though on a near approach its tones may be meagre and thin. Thus sound requires *room* for its perfect development;—and as a rare painting, which on near inspection appears crude and unfinished, will ripen into harmony and just proportions when allowed its requisite distance, so, in the case of a musical performance, an ample space has, in itself, a mellowing influence upon the harshness that always exists in greater or less degree, seeming as it were to purify the sound in some measure of its inharmonious elements and suffer it to fall with richer effect upon the ear.

Thus far, in this connection, we have spoken only of orchestral and choral harmony; but it is a mistake to suppose that choral or orchestral floods of sound are required to fill such ample space, while the tones of a single voice therein would be embayed or lost. There is a lustre likewise imparted to the intonation of a single voice or instrument, in similar circumstances, when rightly managed, such as no narrow limits can give. We speak here of an apartment constructed in accordance with the principles previously given, in which the sound is not unduly absorbed, overpowered, wasted or confused.

According to the experiments of Mr. Benjamin Wyatt, it appears that the geometrical figure which comes nearest to the extreme limits of the natural expansion of the voice in speaking, is a semi-circle of seventy-five feet radius, continued on each side to the extent of seventeen feet, or in the proportions of about two-ninths of its lateral expansion beyond the limits of the semi-circle, and then converging suddenly until the two lines meet behind the back of the speaker; in other words, that the reach of the voice, when moderately exerted, was in the proportion of about two-ninths farther in a direct line than laterally; and that being distinctly audible on each side of the speaker at a distance of seventy-five feet it will be as plainly heard at a distance of ninety-two feet in front of him, declining in strength behind him so as not to be clearly heard at much more than thirty feet. The following diagram will aid us to understand this; the position of the speaker is represented by the point of intersection of the straight lines.*

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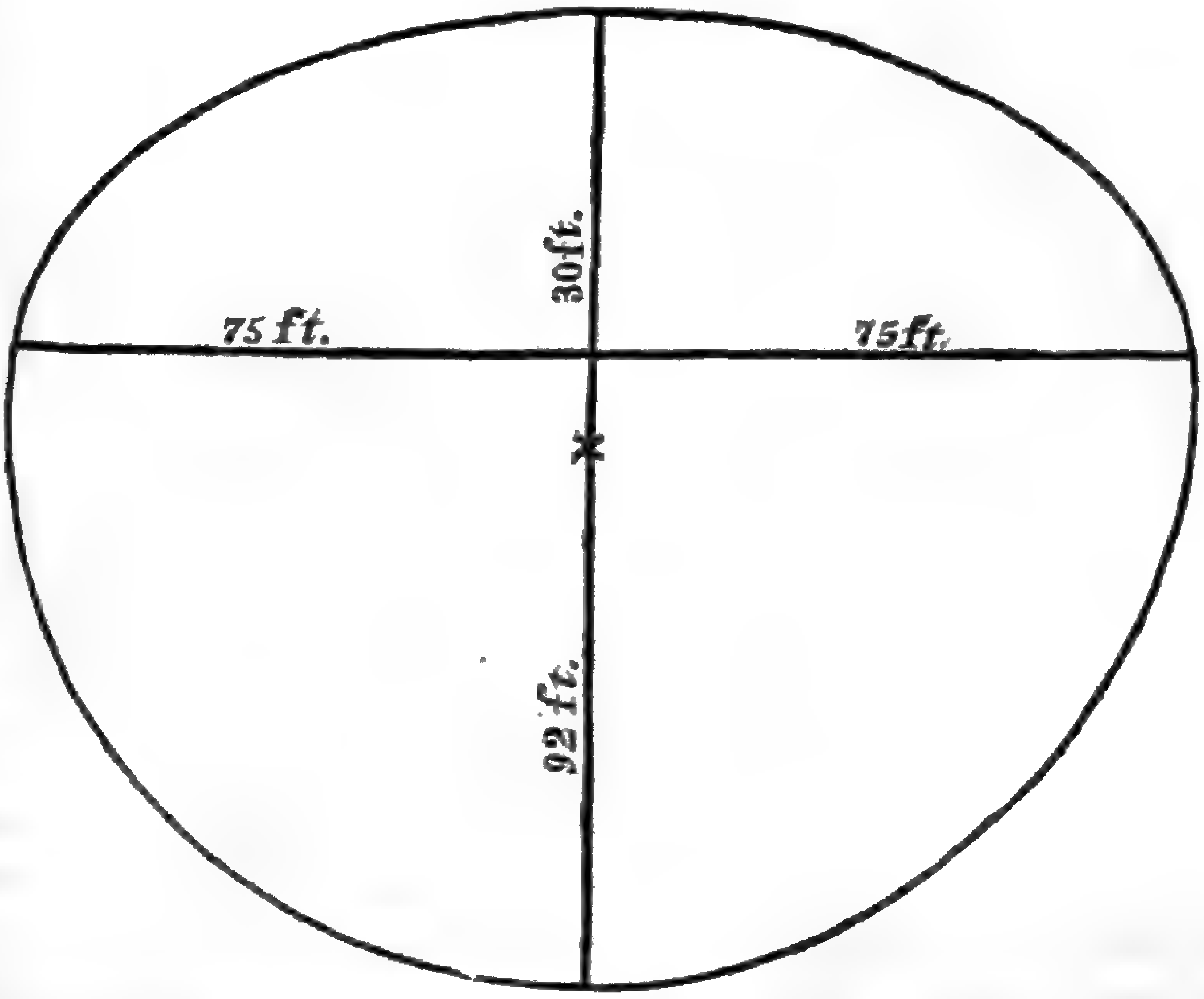

The figure that would conform to these measurements it will be seen is an imperfect ellipse whose major and minor axes are respectively 150 and 122 feet. This is the space allotted to the sound in the ordinary exertions of speaking, and under the usual conditions of the atmosphere. We have seen, however, that, when the medium is in a state of absolute purity, vocal sounds are readily conveyed over an extent far greater than that just stated. We shall have occasion to allude to this point again when we come to the subject of ventilation and warming.

The calculations of Mr. Wyatt, we repeat, refer only to the power of the vocal tones in the ordinary efforts of articulate speech; but of the capacity of the human voice, when rightly exercised *in song*, to fill completely a space much larger than that above designated, we have no doubt. As noticed in a previous chapter, a musical tone reaches farther than other sounds of the same intensity; in illustration of which it is only necessary to instance the effect of the liturgy recited in the cathedrals abroad, where, as must have been often observed, the mass, which is performed in musical tones, becomes audible in the remotest part of the church, whereas, had the same service been read, the

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* Vide Gwilt's Encyclopedia of Architecture.

sound would have been wholly lost. The tones of a Cremona violin which were not conspicuous in the rank and file of the orchestra, have been observed to stand out with singular prominence and beauty as the hearer receded to a distance. It follows, as a corollary from this, that a perfect intonation of voice or instrument is required to insure its legitimate and full power, and in this particular, as has been truly remarked by a keen observer, (Mr. J. S. Dwight,) the effect in a building of proper construction is a measure of the accuracy and excellence of the performance.

In our *choice of materials*, wherewith to form the walls of a structure best adapted for the display of musical effects, we should be guided by the principles laid down on a former page. We have seen that, in the communication of vibrations from one medium to another of different density, a want of homogeneity, in the receiving medium, impairs the quality of the transmitted sound. This is well illustrated by the experiment of Chladni in the communication of the sonorous vibrations from a glass to the contained liquid, when its homogeneity is disturbed. Here the sound is excited in a solid and transmitted to a fluid medium. Conversely, this experiment is repeated upon a larger scale whenever a musical tone is excited in the contained air of a room.

We also found, when treating of the propagation of sound in different media, that the resonance of solid bodies is in the ratio of their conducting power, which latter depends, in great degree upon hardness and elasticity, and uniformity of structure.

In the proper structure and conformation, therefore, of the walls and ceiling of every musical room, are found the primary conditions of its resonance and perfect intonation. Reasoning from the data afforded in the vibration of musical strings, we have previously enjoined the use of harmonic measurements in the general proportions and subdivisions of such rooms, for the securing of the free vibration and consequent resonance of the whole and its parts. But this is presupposing such unity of structure as before mentioned, without which no harmonic proportions would produce the intended results.

In the selection of materials for building we are of necessity limited to wood, brick and stone. Of the woods, various species of the pine appear to be among the best resonants and conductors of sound, and are therefore well fitted for our purpose. Should a building be entirely constructed of this material (we have no reference here to a mere lining of wood) it would doubtless best answer the end in view. But the greater expense and risk attending this mode of building will prove a sufficient objection to its use.

Between brick and stone, there seems to be but little choice. By the preceding considerations, however, we are led to the opinion that the one or the other should alone be employed, and that the substance used as a cement should partake of the nature of the solid material, that thus the whole mass may more nearly resemble a uniform structure. In this connection arises the question as to the proper finish of the internal face of such wall, this being the surface presented to the sound.

(*To be continued.*)

Art. XL.—*Notice of the Meteoric Iron found near Seneca River, Cayuga County, N. Y.*; by Charles Upham Shepard, M.D.

This iron was very briefly announced in the November number of this Journal (vol. xiv, p. 439,) by Prof. O. Root of Hamilton College, Clinton, N. Y. The weight of the mass was between eight and ten pounds. It was picked up by a farmer, while engaged in excavating a ditch; his attention having been arrested by its unusual weight, as compared with ordinary stones. A thick coating of limonite (hydrous oxyd of iron) formed the entire outside of the mass. Its general figure was somewhat drop-shape; although the customary depressions found on the surfaces of meteorites, were visible also, in the present instance.

I am indebted to Prof. Root for a very perfect tetrahedral fragment (of about two ounces weight) which must have formed the little end of the meteor; and to Le-Roy C. Partridge, Esq., of Seneca Falls for a thick slice (of four and a half ounces) which apparently, is a section across the mass, next below the above.

The figure here given represents the broadest face of the latter specimen, with the Widmannstättian figures, as developed by hydrochloric acid on a portion of its surface.

The broad, unshaded bars, which meet at angles of 60° and 120°, are quickly brought out by the acid, their own surfaces not being corroded in the slightest degree by the chemical action, which is confined to the linear intervals between the bars, to the triangular and rhomboidal patches which are shaded in the drawing, and to the borders of the very circumscribed and irregular areas, situated upon a few of the bars themselves. These regions are completely covered during the operation, with little bubbles of nearly pure hydrogen gas.

After the corrosion has been permitted to go on for a number of minutes, the linear intervals above mentioned, exhibit a checked appearance, as if a single row of little prisms had been inserted between the broad bars. These prisms evidently consist of the same alloy as the broad pillars, between which they are thrust, since their tops, like the surfaces of the bars, escape corrosion, and are left after the action has ceased at the same level with the bars themselves. Their presence, in the peculiar position they occupy, confers upon this iron a very remarkable feature, totally unlike any other I have seen. Indeed in all other highly crystalline specimens, we have a series of perfectly continuous lines and edges, in place of the checkered rows here displayed.

The shaded triangular and rhomboidal areas, when their surfaces are well cleaned by a dilute aqua regia (and polished), and examined under a lens, are seen to be finely striated with the same beaded or checkered lines as those above described in the linear intervals.

The more circumscribed areas (three of which are represented in the central bar of the figure) consist of a silver-white mineral, believed to be new; and which will be more particularly described farther on. This substance is not acted upon by the hydrochloric acid; but an envelop of meteoric pyrites, by which it is more or less surrounded, is briskly attacked: and from these regions the odor of sulphuretted hydrogen is plainly perceived. At a place marked A in the figure, is a semicircular vein of this white mineral, where the pyrites is quite abundant.

The want of continuity in the larger bars and their rounded terminations also, serve still farther to distinguish at first glance, the Seneca River iron from nearly all others.

A solution of sulphate of copper dropped upon a moistened surface of the iron, immediately gives rise to a precipitate of metallic copper. It is therefore not in the passive state of the Greene county (Tenn.) iron, and of some others, as discovered by Wöhler.

Beneath the coating of limonite is found a very distinct layer of compact, black magnetite, which must have constituted the original crust of the meteor. Its thickness in some places is $\frac{1}{10}$th of an inch. The specific gravity of the iron is 7·337.

It possesses a medium hardness, and takes a very high polish, having the customary greyish white tint. In this respect as well as in many other particulars, it differs widely from the Burlington iron,* which is remarkable for its whiteness. The tendency to cleavage in the Seneca River mass is very obvious; and when

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* The Burlington iron was found 90 miles to the eastward of the present mass.

torn asunder, in place of presenting a hackly fracture, leaves surfaces with pyramidal cavities and projections.

Analysis.—The iron dissolved very slowly in cold hydrochloric acid, attended by the extrication of hydrogen gas, along with which, sulphuretted hydrogen was occasionally evolved,—as became apparent by passing the gas through a solution of nitrate of silver. As the solution proceeded the surface of the iron became coated with a brownish flocculent matter, resembling somewhat the development of carbon on steel by nitric acid. These flocculi at length separated from the iron, collected into light coherent masses, and floated about in the liquid,—discharging little bubbles of gas, and subsiding finally in masses of much diminished size to the bottom, where they rested upon the broken crystals of the shining white, metallic mineral, above referred to.

As the solution proceeded very slowly, it was repeatedly quickened by a gentle heat, for half an hour at a time. Three days elapsed however, before the action of the hydrochloric acid was completed upon 50 grains of the iron. A second fragment of 20 grains was treated in a similar manner, and with the same general result.

Among the insoluble matter from the first fragment were found two very brilliant, black, octahedral crystals, whose weight together was only 0·005 of a grain. They were unmagnetic. Each of them was measured by the reflective goniometer, and clearly ascertained to be a regular octahedron. And as chromium was found in the acid solution of the iron, it cannot perhaps be regarded as an unauthorized assumption, to consider these crystals belonging to the species chromite, the more especially as this mineral has repeatedly been observed in meteorites, though never before, in well pronounced crystals.

The brown powder amounted, when dry, to 0·125 of a grain. It was partially acted upon by aqua regia; but in other respects appeared identical with that insoluble ingredient in several meteors which I have called dyslytite, and which besides a decided content of silicon, has iron, nickel, phosphorus, chromium and carbon, in some unknown combination.*

The remaining insoluble matter, the white (slightly bronze-colored) crystallized substance, whose weight was 1·05 p. c. of the iron, is a mineral which I believe to be undescribed, if not wholly new. It may have been seen before; but if so, it would appear to have been confounded with the foliated, metallic sub-

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* The gradual shrinking of this flocculent matter under the long continued action of the hydrochloric acid, attended with the escape of gas, suggested the idea, that if nitrogen exists in these bodies, it might perhaps be detected here, as a solid, or rather as a pulverulent azotide of iron, nickel or chromium, analogous to the known azotide of copper, Cu^3N, dicovered by M. Schrœtter (Ann. der Pharm., xxxvii, 129). The same chemist has actually described an azotide of chromium. These compounds are decomposed by heat and by strong acids.

stance, which is also insoluble, and which has been called Schreibersite by Patera; though this designation cannot be maintained, inasmuch as I had previously called another meteoric mineral by this name.

I propose the name of *Partschite* for the substance now under consideration, in honor of the eminent Prof. Paul Partsch of Vienna, whose contributions to astrolithology in the description of the meteoric collection of the Imperial Museum at Vienna, have been so important to the progress of this interesting branch of knowledge.

Properties of *Schreibersite* of Patera.	Properties of *Partschite.*
H.=6·6.	H.=5·6.
Sp. gr.=7·01—7·22.	
Magnetic.	Magnetic.
Color bronze-yellow.	Color silver-white, or only with a tinge of reddish-grey.
Elastic.	Brittle.
In thin plates.	In four-sided oblique prisms, with dihedral summits, whose faces correspond to the prismatic edges.
	Streak dark grey.
Composition.—Iron, 87·20; nickel, 7·24; phosphorus, 7·26; carbon ? =98·70.	When powdered, quickly soluble in aqua regia. It contains iron, nickel, magnesium, and phosphorus.

The proportions of the different substances forming the Seneca River meteorite, as ascertained in the two analyses, were as follows:—

Nickeliferous iron,	98·69
Partschite, (with trace of pyrites,)	1·05
Dyslytite,	0·25
Chromite,	0·01
	100·00

The nickeliferous iron gave,

Iron,	92·40
Nickel,	7·60
	100·00

Chromium, magnesium, tin, manganese? phosphorus, sulphur, in *traces.*

Charleston, S. C., Dec. 24th, 1852.

Art. XLI.—*Notice of the "Mastodon Giganteus" of Dr. J. C. Warren.*[*]

We have already briefly announced the publication of the magnificent volume on the "Mastodon Giganteus," by the eminent surgeon and scholar, Dr. Warren. Turning aside from the profession which he has honored by his profound knowledge and successful labors, he here enters the arena of Science, and substantiates his claims to a distinguished place among the Zoologists of the age.

Dr. Warren has the rare pleasure of possessing the noblest specimen of the Mastodon giganteus that has yet been discovered; and fortunate it is for the old mastodon, that it has found a final resting place with one who has had the generosity and ability to raise so munificent a mausoleum to its memory. A second skeleton was afterwards purchased by Dr. Warren, to aid him in his researches; and, for the same purpose, he has also added to his collection the skeleton of an elephant. This elephant—the one accidentally drowned a few years since in the Delaware—stands in his fine hall, by the side of the huge mastodon, and although a large animal of the kind, it is but a pigmy in comparison. Dr. Warren was thus well equipped for the prosecution of his researches; and no labor or expense has been spared, either in carrying forward his investigations or in the publication of his results.

The title page of the volume presents a view of the region near Newburgh on the Hudson, where the skeleton was exhumed. Among wooded hills lies a large morass, part of which in the front of the scene, has been excavated by the removal of the surface peat of the bog, and the subjacent marl, leaving the skeleton as it was found lying sprawling out, with the ribs and nearly every bone in place. The fore-feet extend beyond the head, and the hinder are thrown forward near the body.

It was in the summer of 1845 that this burial place of the ancient giant was first disturbed. The swampy land was then dry. Mr. Brewster, while digging in the place to obtain the earth for fertilizing his fields in the vicinity, after penetrating through two feet of peat bog, one foot of red moss, and a foot of the shell marl, struck upon the head of the animal. The exhumation went on rapidly the next day, and the cranium, "bones of the spine, tail, pelvis and ribs were successively found, for the most part in their natural relation to each other;" and at the end of the second day, nearly the whole skeleton had been exposed. The bones

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[*] Description of a Skeleton of the Mastodon Giganteus of North America, by John C. Warren, M.D., &c. 219 pp. 4to, with a frontispiece and 27 plates in 4to. Boston: 1852. J. Wilson & Son, 22 School Street.

were in an admirable state of preservation. It seems from the position, Dr. Warren observes, as if the animal had stretched out its fore feet in a forward direction, to extricate itself from a morass into which it had sunk.

Even the undigested food of the animal appears to have been partly preserved. Dr. Prime testifies that[*] "in the midst of the ribs, imbedded in the marl, and unmixed with shells or carbonate of lime, was a mass of matter composed principally of the twigs of trees, broken into pieces of about two inches in length, and varying in size from very small twigs to half an inch in diameter. There was mixed with these a large quantity of finer vegetable substance like finely divided leaves; the whole amounting to from four to six bushels. From the appearance of this and its situation, it was supposed to be the contents of the stomach; and this opinion was confirmed on removing the pelvis, underneath which in the direction of the last of the intestines, was a train of the same material, about three feet in length, and four inches in diameter." The subsequent examination of a portion of this material by Dr. Warren, Prof. Gray, and Dr. Carpenter, supports the opinion here expressed; and both from this case and other examples of exhumed mastodons, it is shown that the mastodon lived on stems or twigs of trees; part of the material found was probably "some kind of spruce or fir."

Such are some of the facts which are here published by Dr. Warren concerning the discovery and food of the mastodon.

In his account of the animal, after his historical sketch, and some observations on the name of the species, he enters upon the description of the various parts of the skeleton, in detail; and excellent lithographic plates illustrate these chapters. One of these plates, of very large size, represents, in an admirable style, the entire skeleton. The following are some of the dimensions given:

	Feet.	In.
Height of skeleton,	11	
Length from anterior extremity of face to the commencement of the tail,	17	
Circumference of the trunk around the ribs,	16	5
Length of tail,	6	8
" " trunk,	10	3
" " head from the occipital condyles in a straight line to anterior edge of tusk-socket,	3	2
Entire length of tusk,	10	11
Depth of socket of tusk,	2	3
External length of tusk,	8	8

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[*] p. 144.

There are 7 cervical vertebræ, 20 dorsal, 3 lumbar, and 5 sacral. The ribs are twenty in number, 13 true, and 7 false. From the 6th to the 11th their length is between 52 and 54¾ inches. The first has more the appearance of a clavicle than a rib, and is 28 inches long. Bearing on the number of ribs, Dr. Warren observes, (p. 31,)

> "The last two false ribs on the right side are co-ossified for the space of 8 inches;—the result of a fracture near their vertebral attachments: the union of these ribs, at its broadest part, measures 8 inches. These bones are perfectly smooth within, and without are quite strong, at the place of union and massive. This fracture is of great importance, as by the union is verified the remark of Cuvier, who found only 19 ribs, but stated that there would, in his opinion, be hereafter found twenty—a fact entirely established in this specimen, first by the articular surface on the side of the 20th dorsal vertebra; and second, by the co-ossification of the 19th and 20th ribs."

After describing the several bones throughout the structure, the author treats at considerable length of the characters of the teeth. Those of the elephant are first described by way of comparison, their number (twenty-four exclusive of the tusks), composition, and form being considered. On taking up the odontography of the mastodon, the author commences with some general observations, and then proceeds to a minute account of each of the teeth in succession. Omitting the mass of details, we cite the following from his General Remarks, pages 61 to 64:

> "While the teeth of the elephant are, as already said, composed of three kinds of hard matter, dentine, enamel, and cement, those of the Mastodon giganteus are constituted principally of two of these substances, dentine and enamel. Prof. Owen has shown that a layer of cement invests the fangs, and is spread over the crown, but the basis of the crown and of the fangs is formed by the dentine; while in the teeth of the elephant, and some others of the Pachydermata, the cement, by its perpendicular interposed layers, constitutes a substantial part of the body of the tooth, as well as a protecting covering to its surface. A great portion of the Mastodon tooth is formed by dentine. The mamillary eminences, or mastoid projections also have a basis of the same substance, but they are invested with a covering of enamel, which in molar teeth in my possession, measures from the sixth to the fourth of an inch in thickness. In teeth which have been worn, the enamel is ground down in various degrees; thus altering the surface of the crown to an appearance approximating, in the Mastodon giganteus, to the lozenge-shaped ridges of the African Elephant.
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> The number of the teeth was long involved in mystery. The genius of Cuvier opened the way to a knowledge of their number, differences and development. He advanced no farther in the path he had opened than to the fourth, or, at the utmost, fifth tooth; making the

whole number to be from sixteen to twenty, exclusive of the great incisors or tusks.

In 1831, Dr. Hays, the distinguished editor of the 'American Journal of the Medical Sciences,' read a paper before the American Philosophical Society, in which he described various jaws of the Mastodon giganteus, and the teeth contained in them. He seems to have been the first writer who clearly pointed out the probability that the number of these teeth was six on each side of each jaw in the Mastodon giganteus, and of course the whole number twenty-four. He says 'the whole number of teeth possessed by the animal described by Dr. Godman (Tetracaulodon) is then at least twenty; and we think that it is at least probable, that the animal possessed an intermediate tooth between the second tooth with three denticles, and that with four denticles. Should we be correct in our views, this animal possessed three teeth with three denticles in each side of each jaw, making the whole number of teeth twenty-four; but to render this certain would require specimens of intermediate ages to those hitherto described.' These have since been obtained, and have fully confirmed the opinion suggested by the sagacity of Dr. Hays. In the collection of the Cambridge University, there is a series of jaws affording a perfect demonstration of this fact, and settling the number to be twenty-four. Professor Horner, in a paper read to the Philosophical Society, thought that there might be a greater number. De Blainville makes them twenty-four.

The specimens in the collection of the American Philosophical Society, those of Cambridge University, various others in New York, Albany, and in my private collection, support the opinion that the number is twenty-four, and no more.

The teeth are not all developed at the same time, but in succession, in proportion to the waste of those which have preceded. At first appear two small deciduous teeth, or milk molars; next follows a third tooth, also deciduous, larger and more complicated than the former; then a fourth tooth, of the same form as the last, though greater in size. These four teeth sometimes co-exist, as in the Tetracaulodon's jaw, from the museum in New York, originally described by Dr. Godman, and afterwards more particularly described and represented by Dr. Hays in the 'Transactions of the American Philosophical Society,' vol. iv. To the teeth already mentioned succeeds a fifth tooth, of the same form as the last, but rather larger. Before the appearance of this, and even in most cases before the fourth tooth shows itself, one or more of the first teeth have disappeared. The sixth and last tooth is much larger, and formed in a mould different from any of the others."

The plates represent in beautiful style the dentition of several skeletons, exhibiting the jaws and teeth of different ages.

The *tusks*, which are *incisor teeth*, enormously developed, are treated of in the following chapter, as follows, pp. 87—90:

"Besides the regular intermaxillary tusks, there are two very small ones, which show themselves in the upper jaw at the earliest period of life, but shortly disappear and are succeeded by the permanent tusks. This is shown by cutting into the tusk-socket of our calf elephant head.

The fact well established in regard to the elephant, seems to afford presumption, that besides the great intermaxillary tusks of the Mastodon, there may be others in the upper or lower jaw, which appearing at an early period of life, are, in the greater number of instances, lost before the animal has advanced far in its existence.

In the present specimen of the Mastodon, there are two tusks in the upper and one in the lower jaw on the left side. Two undoubtedly existed in the lower jaw, at an early period of life, as the relic of the right cavity is perfectly distinct, retaining a depth of an inch and a half, and nearly its original diameter.

The Superior Tusks.—The tusks of the upper jaw were ten feet and eleven inches long; but being broken soon after exhumation, only the anterior termination of each (in length about four feet and in diameter at the truncated extremity five inches) remains in a perfect condition. The middle portion, rather more than two feet, has crumbled. The posterior portion, of about the same length with the anterior, is broken into laminæ; it is flattened at the base, so as to be half an inch longer in one diameter than in the other, making the largest seven inches and a half. The bases are surrounded externally by circular elevations, at first two inches distant from each other, but gradually increasing in distance, until, at about two feet from the extremities of the bases, they disappear entirely.

The tusk is composed of laminæ which at the internal extremity of the socket, are not more than a line in thickness. These laminæ increase in number as we advance from the butts, so that where the tusk issues from its socket at the distance of rather more than two feet from the posterior extremity, the internal cavity has diminished from seven inches in diameter to two by two and a half. The plates into which the tusk has separated in drying are generally an eighth of an inch in thickness, some of them nearly an inch. The external surface has a brown appearance; the layers which have been recently uncovered are of a lighter color.

The following analysis of a portion of the tusk has been kindly furnished me by Dr. Chas. T. Jackson:

'Animal matter (cartilage),	26·2
Phosphate and carb. of lime, fluorid of calcium, &c.,	69·2
Water,	4·6
	100·0

Glass was etched with the fluorine. The constituents of the tusk are phosphate of lime, carbonate of lime, fluorid of calcium, phosphate of magnesia, soda, sulphur.'

The laminæ at the anterior part of one of the tusks, which is best preserved, are superficially not more than half a line in thickness; they are divided or split by longitudinal fissures about three-fourths of an inch apart; and they present none of the circular marks seen at the posterior extremity. The point anteriorly is worn away for the space of two inches on one side, as is generally found to occur in the tusks of the proboscidian family.

When the tusks were first discovered, they lay with their convexities outwards, their points approaching each other; having apparently turned in their sockets after the soft parts which retained them were decomposed so as to loosen their attachments. For the weight of the head inclined the butts downwards, while the resistance of the marl on their inferior and internal sides would give a rotary motion outward and upwards to a definite extent. In this direction they were placed by Dr. Prime, who had an opportunity of observing them in their original position in the embedding marl. Although the extremities of the butts are somewhat oval, the greater size of their sockets owing to the decomposition of the soft textures which lined them, would readily admit the butts of the tusks to be placed in any direction; and considering the apparent inutility and the remarkable anomaly of the position before mentioned, we thought it right to change their opposing aspect to one more consonant with the character and attitude of the skeleton.

The Inferior or Mandibular Tusk.—The small mandibular tusk has been brought into notice of late years by Dr. Godman, who considered it as characterizing a new species, to which he gave the name of Tetracaulodon, as will be shown hereafter. Professor Owen has attached a new importance to this tusk, as one distinctive character between the genus Mastodon, and the genus Elephas; a distinction which M. de Blainville, Dr. Falconer and others, have been willing to pass over. But hitherto, so far as we know, the existence of this part in the elephant has not been discovered; while it is perfectly established in regard to the principal species of Mastodon, the Mastodon giganteus, and Mastodon angustidens. So long as this fact remains uncontroverted, we should consider it, taken in connection with other facts, as forming an impassable boundary between the two families.

This tusk is eleven inches long, five and a half in circumference, and two in diameter at the base; being longer by an inch than the cast of a similar one in the collection of the American Philosophical Society, which was taken from the specimen originally described by Dr. Godman, and disinterred by Mr. Archibald Crawford near Newburgh. The direction of our tusk is forward and downward, forming an angle with a horizontal line of about 45°. It has a cavity an inch and a half in diameter at the internal extremity, the thickness of the edge being one-fourth of an inch; this cavity is of a conical form, and two inches deep. The rest of the tusk appears to be solid. The anterior extremity is rounded and about an inch in diameter; on one side it has been worn away to the extent of four inches. The worn surface is smooth at its extremity only, the rest being quite rough; the depth of the external layer is exposed in this abrasion, and exhibits the thickness of an eighth of an inch. Near the posterior or internal extremity are seen a number of circles, to the amount of ten or eleven, extending from the base, to two or three inches forward, and occupying that part which lay in the socket. The surface of the tusk generally exhibits longitudinal striæ, in some of which, cracks begin to appear from desiccation. These striæ are distant from each other from a fourth to an eighth of an inch. The color of the tusk is brown, excepting three inches of its anterior extremity, which are nearly black. At the fissures it is seen to be composed of laminæ about the sixth of an inch in thickness. It is perfectly firm and free from any marked evidence of decomposition."

Dr. Warren mentions more or less fully and figures other Mastodon skeletons found in the United States. Plates 16, 18, 19, are devoted to the Shawangunk head found at Scotchtown, Orange Co., New York, which is particularly described. The size of this head is not exceeded by that of any other hitherto discovered. Its greatest breadth is 31 inches, its vertical elevation 33¼ inches and the length from the ridge of the occipital plane to the extremity of the intermaxillary bones, is 48 inches.

The characteristics of some other species of Mastodon occupy several pages of the work; and the so-called *Tetracaulodon* is recognized as the male of Mastodon giganteus.

The work closes with a dissertation on the food and supposed discovery of hair of the M. giganteus, and on its geological situation and causes of preservation. The author states that of the five skeletons known at this time, three have been found in the fresh water marshes of Orange Co., N. Y., a fourth in an interior morass in New Jersey, and the fifth near the banks of the Missouri, probably in a fresh water deposit. Scattered bones are common from various parts of the country, and even from the far north. They are reported from the surface soil, peat marshes, beds of marl or loam, etc.; but, as Lyell observes, there is yet no satisfactory evidence of their occurrence beneath the proper drift.

The North American Mastodon bones hitherto found appear to belong to the same species, excepting a single tooth, reported from Caroline County, Maryland. Dr. Warren enters into the history of this tooth, discusses the possibility of its being a stray tooth from another continent, and concludes that it is what it purports to be, a true Maryland fossil, closely related to the Mastodon Humboldtius (or M. *angustidens* if the two are one), of South America, if not identical with it.

An Appendix contains various facts of interest, and among them a description of a specimen of the Mastodon angustidens found near Turin, (called the Dusina Mastodon), taken from Sismonda's "Osteografia di un Mastodonte angustidente," published at Turin, in 1851.

Art. XLII.—*Notices of the Rarer Minerals and New Localities in Western North Carolina;* by C. L. Hunter, M.D.

The Diamond.—The occurrence of the diamond in the United States is now no longer a matter of doubt or uncertainty. On the first announcement a few years since of its discovery in North Carolina, the unexpected information could scarcely be credited by the scientific or intelligent portion of the community, although geological indications favored its existence in the auriferous region of the South. By some, the truth of the newspaper account was totally denied, and set down as only a *marvellous story.* By others, it was more charitably pronounced a *mistake* in the discoverer, on the ground that diamonds could be found only in South America, or the East Indies. The little gem, however, after a time was produced and exhibited to several scientific individuals, including Prof. Silliman and Prof. Shepard, who pronounced upon its genuineness in accordance with the published statement. This *first* diamond was found, several years since, in Rutherford County, N. C., in the gold washings commonly known as *alluvial deposit.* It weighs about one carat and a half, is of a yellowish color, and presents one of the elongated *adamantoid* shapes. It may be seen figured in both Dana's and Shepard's Mineralogy (3d edition). Early in the spring of the past year (1852) another diamond was found by the writer of this article, in a similar deposit, in Lincoln Co., N. C. It weighs about half a carat, is nearly clear, with a delicate greenish tinge, and presents the same elongated shape as the Rutherford diamond. In the summer also of the past year another diamond was found in Mecklenburg County, N. C. It weighs about three-fourths of a carat, is nearly of the first water, and resembles more nearly than either of the preceding, a brilliant, just elaborated by the artistic skill of the lapidary. It is also reported upon good authority that several small diamonds have been found in the gold washings of Georgia. In every instance, thus far, these little gems have been found in alluvial deposit, or drift, in which may be seen rounded pebbles. The peculiar conglomerate called *cascalho,* strictly speaking, has not been identified; but in several places I have seen a stratum of gravel very compact, and agglutinated as it were by a ferruginous sedimentary *cement,* constituting an aggregate somewhat analogous to this, and perhaps, the repository of the diamond. Be this as it may, the encouraging fact is here presented that in the auriferous region, extending from Mecklenburg Co. to Rutherford Co. in North Carolina, and thence southerly to Hall Co. in Georgia, embracing a section of country at least 75 miles wide by 150 long, the diamond may be sought for by the gold miner, with every prospect of success. It is to be regretted that these recent discoveries had not been made previous to the extensive gold mining operations in Burke, McDowell, Rutherford, Lincoln, and several other Counties. In passing through these Counties we frequently meet with large gravel-piles, extending for miles along the different water-courses. Nearly all of this work was done in a hurried manner, regardless of any other reward than the "yellow dust," scattered, in many places, quite abundantly through the deposit. Such being the case, is it not probable that these deserted gravel-piles may still contain much hidden treasure? And would it not be advisable for all who are now engaged in working *deposit* *mines* in the Southern States, or in California, to keep a "sharp look out" for this rare and valuable gem?

Gold.—In noticing this rather abundant metal, it is not intended to tire the reader with a lengthy detail of *golden statistics*, with which our newspapers are almost daily teeming, but simply to present a few curious facts, not generally known, connected with the *history of its discovery* in this country. The first gold found in North Carolina, and probably in the United States, in valuable quantity, (always excepting the mysterious diggings, and unknown discoveries of our aboriginal predecessors,) was in 1799, at the celebrated "Reed Mine," in Cabarrus County, N. C. It was found by a little son of Mr. Reed, about 12 years old, while amusing himself with bow and arrow in shooting for fish on a small stream called "Meadow Creek." The lump of "yellow metal" thus discovered, said to have been of the size of a "small smoothing-iron," was taken home, and retained several years by his father, without knowing its name or value! No one at that early period presumed to think that gold existed in North Carolina, or even in the United States. In 1802, Mr. Reed carried the "lump of strange metal" in his wagon to Fayetteville, an inland town of considerable trade; and while there showed it to a jeweller to ascertain its true name. The jeweller after a slight examination, informed him it was *gold*, and immediately proposed buying it. To this proposal its owner readily acceded, and sold it to the jeweller for the trifling sum of three dollars and fifty cents! This information, although dearly bought, like Franklin's whistle, was highly serviceable to Mr. Reed in leading to future discoveries of great value. In 1803 he associated himself with three others for working the mine, and soon afterwards was richly rewarded by finding the large mass so extensively known, weighing "28 lbs. steelyard weight." In 1804, and a few subsequent years, numerous other masses or "lumps" were found, weighing from one ounce to sixteen pounds. In the "Medical Repository," published in 1804, this early discovery of gold in North Carolina is properly noticed. It is not surprising that these first developments should, for a time, have greatly excited the public mind. Such is a brief history of the *golden discoveries*, and such the origin of the "gold fever" in North Carolina, whose contagious influences have spread, not only to her sister states of Virginia, South Carolina, and Georgia, but to the distant shores of the Pacific, and now threaten to disturb the equanimity of the "Green Mountain boys." Thus both extremes of the Alleghany chain—its southern and northern termini—and the auriferous valleys of the more lofty Rocky Mountains, have been aroused to arms,—not of slaughter, but to new employment of the *pick* and the *shovel.*

Corundum.—A few years since, a straggling bowlder of corundum was found in Buncombe County, N. C. The mass, when broken afforded good specimens of a deep blue color, and highly crystalline lamellated structure. As it was merely an erratic block, it would be well for the mineralogical tourist to search for its original situation in the adjacent mountain ranges whence it was probably *drifted.* During the spring of last year I had the pleasure of discovering a locality of this mineral in Gaston Co., N. C. The specimens thus far obtained, although small, not exceeding 3 or 4 inches in diameter, are interesting from the fact that they were found *in place.* It is quite probable that future exploration will bring to light larger and more valuable specimens. The corundum is here generally associated with an aggregate of *mica* and *quartz.* In some of the specimens, with drusy cavities, may be seen numerous small, flattened, six-sided prisms, arranged singly, and in groups. Some of these crystals, when examined with a glass, are found to be handsomely studded with *specular iron.*

Emery.—At the above corundum locality, may also be obtained emery of good quality associated with *emerylite.* The largest mass procured, about five or six inches in diameter, was exceedingly tough, and difficult of fracture. The gradation in color, from a deep blue corundum to a fine granular emery, nearly black, owing to the mixture of iron, is quite perceptible. This locality is richly worthy of more thorough examination.

Amethyst.—An interesting locality of this mineral is found at Randleman's in Lincoln County. The crystals are remarkable for their size, beauty, and for the splendid groups in which they frequently occur. They are mostly of a smoky, or dark purple color, but occasionally, beautiful pink or rose-colored crystals are found. Perhaps no locality in the southern states has produced so many fine specimens.

Chalcedonic quartz.—An interesting locality of this variety of quartz is found in Rutherford County. The crystals are hollow, nearly pseudomorphs of calcite, and have their interior cavities lined with crystals of chalcedony. Frequently the cavities are filled with water, and hence are known by the name of *water crystals.* This fluid, however, is liable, on exposure, to escape by evaporation through scarcely visible fissures, leaving a yellowish powder, sometimes called *mountain meal.*

Lazulite.—This rare and interesting mineral was first discovered in 1822, by the late Dr. H. S. Hunter, near "Crowder's Mountain," in the southern part of Lincoln County (now Gaston). Specimens were forwarded by him to Prof. Olmsted, then attached to the University of North Carolina, and noticed in his

"Report," (2d part) addressed to the "Board of Agriculture." A few years since, a more abundant locality was discovered about 20 miles northeast of the former near the southern terminus of Clubb's Mountain. The lazulite is here found pervading an *arenaceous* and *micaceous quartz*, appearing to constitute its matrix. Occasionally it is found imbedded in *compact quartz*, and in the triangular cavities of a *reddish kyanite.* It occurs massive, but imperfect crystallizations may be traced on some of the specimens. This locality is exceedingly rich in the variety of its mineral productions, including gold, the most precious, and iron, the most useful of metals. Here, from a gently rising elevation of two or three acres, the mineralogist may obtain the handsome addition to his cabinet of twelve or fifteen different species—some of them rare and quite desirable.

Kyanite.—At the lazulite locality just noticed are also found several varieties of kyanite, constituting, perhaps, two or more species. Some of the specimens are of a handsome bluish green color, with numerous lamellæ diverging in different directions. Sometimes kyanite and talc or pyrophyllite are associated, forming large globular masses. This is the locality alluded to in Shepard's Mineralogy (3d edition) but wrongly printed "Chubb's Mountain." It derives its name from one Gasper Clubb, a submontane resident of the Revolutionary period, whose eccentricity of character and marvellous tales are still remembered by the older inhabitants.

Leopardite.—This is a singular *spotted rock,* found in Mecklenburg County, in the vicinity of the flourishing town of Charlotte. It occurs in large masses, generally presenting a *rhomboidal* or *trapezoidal* shape. It is noticed by Prof. Shepard, under the head of feldspar, as the "leopard stone of Charlotte, N. C." It is regarded by the same authority, as a composition of *compact feldspar* and *quartz*, the spots being produced by the *oxyds of iron* and *manganese.* When broken at right angles to the pervading stripes, this mineral presents the singular spotted appearance which has given origin to the name "leopardite." As this name is quite characteristic of a rather unique rock, I would suggest the propriety of retaining its popular designation. Another locality of this rock has recently been found in Lincoln County. The pervading stripes are, however, generally finer; and when broken *diagonally*, it presents a handsome arborescent appearance. It receives a good polish, and might be used for various ornamental purposes. It may be proper here to state that the block, soon to be contributed by the citizens of Charlotte to the National Monument at Washington City, is of *leopardite;* when finished, it will compare favorably with its numerous associates in that lofty structure.

The preceding notices embrace but a small number of the rarer minerals and undescribed localities in western North Carolina. On a future occasion the subject may be resumed, and additional facts and observations presented sufficiently interesting, it is hoped, to claim the attention of the scientific reader.

ART. XLIII.—*Review of Mr. Blake's Article on the Flow of Elastic Fluids*;* by JOEL E. HENDRICKS.

AFTER making some introductory remarks, the writer says:

"If the velocity with which a fluid flows through an orifice be represented by V, the density under which it passes the orifice by D, and the area of the orifice by S, then the product VDS is the measure of the quantity of the fluid discharged in a given time. It is an established law in the dynamics of fluids, that the velocity of the flow is directly as the square root of the pressure, and inversely as the square root of the density. If then the efficient pressure which produces the flow be represented by P, the general law expressed by symbols will be

$$\mathrm{VDS} \propto \frac{\mathrm{DS}\sqrt{\mathrm{P}}}{\sqrt{\mathrm{D}}}.\text{''} \qquad \text{(a)}$$

In order to prove that this formula does not properly represent the relation which the author intended it to represent, I will endeavor to show that the formula (a) is only applicable to cases where P is a *momentary* force, and does not apply in the investigation attempted by Mr. Blake; and that, therefore, his determinations are not to be relied upon as necessarily true.

If a momentary force P impinge upon a body *b*, it will give to that body a velocity V and momentum *m*. And because every effect is proportionate to its cause, we shall have $m \propto \mathrm{P}$. (b)
Also, because the momentum of a body is that body multiplied by its velocity, we have $m = b\mathrm{V}$. (c)
Hence by substituting for *m* in (b) its value as found in (c) we have $b\mathrm{V} \propto \mathrm{P}$, or $\mathrm{V} \propto \frac{\mathrm{P}}{b}$. (d)

And if *b* represent a column of elastic fluid whose transverse section is S; density D, and velocity V, the expression (d) becomes $\mathrm{V} \propto \frac{\mathrm{P}}{\mathrm{VDS}}$, whence $\mathrm{V}^2 \propto \frac{\mathrm{P}}{\mathrm{DS}}$ and $\mathrm{V} \propto \frac{\sqrt{\mathrm{P}}}{\sqrt{\mathrm{DS}}}$. And when

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* Art. No. 12, Vol. 5, (second series) of the Am. Jour. of Science and Arts.

S is constant $V \propto \frac{\sqrt{P}}{\sqrt{D}}$ and consequently

$$VDS \propto \frac{DS\sqrt{P}}{\sqrt{D}}. \qquad (e)$$

Hence if P be a momentary force which acts upon *b* for a single instant, then will the formula (a), which is identical with (e), represent correctly the relation between V, D and P, at the orifice.

Again, if a constant accelerating force P, act continually upon a body *b* during a time *t*, it will give to that body at the end of the time *t* a velocity V and momentum *m*. And because the effect, or momentum *m*, is proportional to its cause, viz: to the force P multiplied by the time *t*, therefore $m \propto tP$. (f) Also because the momentum of a body is equal to the product of the body multiplied by its velocity, we have $m = bV$. (g) And by substituting for *m* in (f) its value as found in (g) we have $bV \propto tP$, or $V \propto \frac{tP}{b}$, whence by substituting VDS for *b* and reducing and supposing S constant, we have $V \propto \frac{\sqrt{tP}}{\sqrt{D}}$, and therefore, by multiplying both sides by DS, we have

$$VDS \propto \frac{SD\sqrt{tP}}{\sqrt{D}}. \qquad (h)$$

Now it is sufficiently obvious that this formula can be identical with (a) only when *t* is equal to unity. Hence if (a) represent generally the relation between V and P, on the supposition that P is a constant accelerating force, it follows that the velocity V in the formula (h) must have been induced in a unit of time, whatever distance the body may have traversed. Wherefore, in that supposition, V must vary as the distance traversed, or as the length of the discharging vessel when the body is a fluid generated at its farther end. But the space traversed by a body in consequence of the action of a constant accelerating force is as the square of the last acquired velocity. Consequently the last acquired velocity, or V in the formula (h), must vary as the square root of the space traversed; and because if the fluid is generated at one end of the discharging vessel, and discharged at the other, the space it will have to traverse after motion commences and before it attains the velocity V will be the length of the discharging vessel, therefore V in the formula (h) must vary as the square root of the length of the discharging vessel. Now because V cannot, at the same time, vary both as the length and as the square root of the length of the discharging vessel, therefore we cannot restrict *t* to unity in the formula (h). And consequently P in the formula (a) cannot be a constant accelerating force.

Lastly, if any variable accelerating force P, act continually upon a body b, it will give to that body at the end of the indefinitely small time dt, a velocity dV and momentum dm. And because the effect or momentum is proportional to its cause, viz: to the force P multiplied by the time of its action dt, we have

$$dm \propto dtP. \qquad \text{(i)}$$

And because the momentum of a body is that body multiplied by its velocity, we have $dm = bdV$. (k)

By substituting for dm in (i) its value as found in (k), we have $bdV \propto dtP$ or $dV \propto \frac{dtP}{b}$, and because b is a constant quantity, we have $V \propto \frac{\int dtP}{b}$, whence by substituting for b its value VDS, reducing, and regarding S constant, we derive $V \propto \frac{\sqrt{\int dtP}}{\sqrt{D}}$, and consequently

$$VDS \propto \frac{DS\sqrt{\int dtP}}{\sqrt{D}}. \qquad \text{(l)}$$

Now it is obvious that this formula (l) cannot be identical with (a), unless P be a constant quantity; but in that case the formula (l) will reduce to (h), which it has been shown cannot be identical with (a), therefore the formula (l) cannot be identical with (a). Consequently P in the formula (a) is *necessarily* a momentary force, and therefore the velocity induced thereby must be uniform. But Mr. Blake has shown independently of the formula (a), that in the flow of elastic fluids, the velocity increases as the fluid approaches the orifice, therefore the formula (a) which he employs in his investigation is not applicable to the case he is considering, and consequently his determinations are not necessarily true.

Auburn, Ind., Feb. 14, 1853.

ART. XLIV.—*On a New System of Electro-Magnets;* by M. J. NICKLÈS.*

THE discrepancy pointed out by me between the conclusion of M. Dub, and that of M. Muller and MM. Lenz and Jacobi, as to the influence of the length of the arms of an electro-magnet on the weight carried by them, is only apparent; each of these opinions is based on a special case. The elongation of the arms has in fact some influence, (as M. Dub asserts,) when, (as done

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* An addition to the former paper at page 104 of this volume.

by this physicist,) strait electro-magnets are experimented with. On the contrary, it is without effect with horse-shoe or bifurcate magnets, which were employed by Lenz and Jacobi as well as M. Muller. This is shown by the following experiments.

1. *Straight Electro-magnets.*—In my experiments I have used a series of cylinders of iron, of the same diameter and increasing lengths, as follows:

	Millimeters.		Millimeters.
No. 1.	0·050 long.	No. 3.	0·150 long.
No. 2.	0·100 long.	No. 4.	0·200 long.

and so on for 5, 6, etc.

The helix consists of 94 metres of copper wire, a millimeter in section, forming a coil of 754 turns. Cylinder No. 3 was placed in the helix. The weights are given in grammes.

Tang. 11° 20′			Tang. 7° 15′		
Length added.	Weight lifted.	Weight falls.	Length added.	Weight lifted.	Weight falls.
0.	1700 gr.	1750	0.	980 gr.	1000
No. 1.	1900	2000	No. 1.	1100	1150
No. 2.	2000	2150	No. 2.	1210	1250
No. 3.	2150	2240	No. 3.	1260	1300
3+1.	2250	2290	3+1.	1300	1320
3+2.	2290	2300	3+2.	1320	1340
No. 6.	2300		No. 6.	1340	1340–45

The influence of the elongation of the magnetic bar upon the attraction is obvious. Nevertheless it has its limit, from which limit the attraction diminishes as the length of the magnet increases. This is shown in the following table, in which the same method was adopted, but with a more feeble current.

	$\frac{\text{Tang. } 11° 20′}{2}$	
Length added.	Weight lifted.	Weight falls.
0.	720	800
No. 1.	845	1000
No. 2.	1000	1170
No. 3.	1050	1140
No. 4.	1150	1220
No. 5.	1050	1200
No. 6.	1050	1210
6+1.	1000	1170
6+2.	950	1000
6+4.	960	990
6+7.	890	940

It is here apparent that the attraction decreases from No. 5. It is also seen that the decrease is more rapid when the bar is made of two or more pieces, instead of being in a single solid piece. This fact, which I have established in various ways, is of great importance in the construction of electro-magnets.

2. *Horse-shoe Magnets.*—As the horse-shoe magnet is only a curved bar with a helix about either extremity, the same results would be expected as with straight bar-magnets, that is, the increase in the length of the arms should exert an influence on the attraction produced by each of the poles *when these poles act singly.* I will mention some of the results which I have obtained, bearing in this direction.

The electro-magnet employed was the system of Mr. Joule,* except that the coarse wire was replaced by 60 metres of wire 1 millimeter in section, making a coil of 324 turns.

Total current, $\frac{\text{tang. } 47° 10'}{2}$		Reduced current, $\frac{\text{tang. } 11°}{2}$	
Iron added to the N. Pole.	Weight borne by the S. Pole.	Iron added to the S. Pole.	Weight borne by the N. Pole.
0 grammes.	180 gr.	0 gr.	175–190 gr.
174	328	174	335
	Current tang. $\frac{15° 10'}{2}$		
320	440	320	430

The same results have been obtained with horse-shoe magnets of different forms, and also with the electro-magnet of 3 arms or *trifurcate,* which variety is the special subject of this notice.

Hence the proposition of M. Dub is true, as long as the armature is in contact with *only one* pole of the magnet. But we shall show that this is not so, when both poles act together.

The experiments were made with two horse-shoe magnets of the same section ($0^{m}\cdot010$) and of different lengths; one, 4 decimeters in total length, the other 8. The helices had each 665 turns of a copper wire, 1 millimeter in section; they were free, so that they might easily be removed. I will call the smaller magnet *b*, and the larger, *b′*. The intensities of the current were ascertained by means of a rheostat.

These determinations had been already made when the memoir of M. Despretz appeared, on the non-proportionality between the tangents of the deviations and the intensities. But it was of no use to apply to these experiments, or to the following, the formula of M. Despretz, as they have special reference to the properties of electro-magnets, leaving out of view the currents which act in them.

The weights carried by the two opposite poles, were in grammes as follows:

	Tan. 4° 20′	Tan. 7° 40′	Tan. 12° 20′
b	5100 grammes. 5300 5100	7500 gr. 7600	10500 gr. 10700

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* Annals of Electricity, v, 187.

	Tan. 4° 20′	Tan. 7° 40′	Tan. 12° 20′
b′	5000 gr. 5200 5100	7289 gr. 7610	10590 gr. 11000

This verifies the results of MM. Lenz and Jacobi, as the length of the arms is without influence on the weights lifted by the magnets.

It should be added that this proposition is true only of horse-shoe magnets furnished with two helices in contrary directions—the condition under which these physicists have experimented. If on the contrary, the two helices are of the same direction, the principle of M. Dub becomes the true one; and it is also the same if the horse-shoe magnet is furnished with only one helix.

As these facts have not yet been presented in a definite formula in any work, I here offer some evidence in their support.

The same electro-magnets were used in these experiments as in the last. I add to the tables of the results, the preceding results, as well as those obtained in determining the weight supported by a single pole of these magnets. The currents are the same as above.

Magnets.	2 poles of same name.	2 poles of cont. name.	2 poles one only with a helix.	A single pole.
		Tan. 4° 20′		
b	2500 gr. 2300	5100 gr. 5200	1800 gr.	600 gr.
b′	3600 3500	5000 5200 5100	510	500
		Tan. 7° 40′		
b	4800 5000	7500 7600	4100	2500 2500
b′	5800 6000	7289 7610	5000 4800	2000
		Tan. 12° 20′		
b	7000 6900	10500 10700	5000 4850	2600
b′	9000 8600	10590 11000	4800 5000	3500

It follows from these facts:—

1. That in all cases, it is an advantage to use both poles even when only one is under the influence of the current.

2. That a horse-shoe magnet, furnished with a single helix, has more attractive power when its arms are short than when long.

It is on these principles, that the trifurcate electro-magnet of mine is constructed.

I will now add more data to complete my former communication. By its properties this electro-magnet calls to mind the magnets "à points conséquents," its middle pole being much stronger than the two outer.

With this magnet we may obtain a rectilinear motion, which I have in fact found to be true, though in a less degree, with the ordinary magnets. I have stated in my preceding note that the two lateral arms of the new magnet are larger than the middle arm. On placing a cylinder of iron at the origin of the arms perpendicular to their direction, this cylinder rolls with great force towards the centre of the magnet, and returns as often as it is put back to its first position. This movement back and forth, which may be increased in extent, takes place, whatever the position of the apparatus, or inclination of the poles.

This movement appears to deserve some attention, for it enables us to construct electro-magnetic machines in which the magnets act in contact, without producing a shock; for it is well known that with the ordinary machines, the shocks when the magnets touch deteriorate rapidly the power of the machine.

The table below gives the force of attraction exerted by these magnets with currents of different intensities. The armature here used has the size of the central arm; it weighs 1030 grammes; and its rectangular form adapts it well for the experiments, since it may be made to touch by the small or long side, in an axial or equatorial direction, according as it may be desired to act with one, two or three poles; and finally, by using the large surface, the magnetic radiation may be almost entirely intercepted, and we may thus obtain the weights lifted as given in the 4th column.

The total current of the battery was tan. 56° 25′; the reduction observed when the helix was in the circuit, tan. 49° 55′. The different intensities were ascertained by means of a rheostat.

				3 Poles.	
	Current.	Middle pole.	2 Poles.	Armature presented by its edge.	Armature presented by its large surface.
Tan.	49° 55′	3 kil.	80 kil.	130 kil.	180 kil.
	46° 10′	2	68	120	142
	14° 45′		6	15	142
	11° 30′		3	4	142

With an armature of different form these relations are changed; thus a rule of iron, $0^{m}\cdot38$ long, $0^{m}\cdot02$ broad, and $0^{m}\cdot004$ thick, has afforded the ratio of $\frac{1}{3}$ between the weight supported by the middle pole and the three polar surfaces united. Cylindrical armatures of $0^{m}\cdot015$ section, have given analogous results.

ART. XLV.—*Abstract of Meteorological Observations made at Burlington, Vt., in* 1852; by Z. THOMPSON.

LOCATION. Lat. 44° 29′, Long. 73° 11′, one mile east of Lake Champlain and 256 feet above it.

1852.	THERMOMETER.				BAROMETER.			
Months.	Mean.	Highest.	Lowest.	Range.	Mean.	Highest.	Lowest.	Range.
	°	°	°	°	Inches.	Inches.	Inches.	Inches.
January, . .	14·36	39	−17	56	29·65	30·14	29·05	1·09
February, .	23·19	52	−12	64	29·60	30·46	28·80	1·66
March, . .	28·50	49	− 8	57	29·72	30·36	28·91	1·45
April, . . .	39·86	58	21	37	29·48	29·84	28·77	1·07
May, . . .	56·16	85	32	53	29·67	30·13	29·20	0·93
June, . . .	64·34	97	39	58	29·57	30·02	28·80	1·22
July, . . .	71·08	93	48	45	29·66	30·00	29·13	0·87
August, . .	66·44	90	47	43	29·74	30·02	29·50	0·52
September, .	59·42	90	34	56	29·75	30·10	28·98	1·12
October, . .	47·95	74	27	47	29·72	30·18	29·32	0·86
November, .	35·58	54	15	39	29·62	30·17	29·00	1·17
December, .	30·32	58	− 4	62	29·71	30·39	29·00	1·39
Annual mean,	44·77			114	29·66			1·69

1852.	WINDS.								WEATHER.		SNOW.	WATER.
Months.	N.	N.E.	E.	S. E.	S.	S. W.	W.	N. W	Fair.	Cloudy.	Inches.	Inches.
January, .	12	2	1	1	12	0	1	2	12	19	24	1·03
February, .	5	1	1	2	12	2	3	3	20	9	17	1·69
March, . .	9	0	1	2	12	0	3	4	16	15	22	1·92
April, . .	13	3	1	2	4	1	3	3	17	13	12	1·15
May, . .	5	1	2	4	9	1	2	7	26	5	0	0·71
June, . .	6	1	0	0	14	2	5	2	25	5	0	4·76
July, . .	4	2	1	1	14	1	5	3	28	3	0	4·99
August, .	11	2	0	1	12	2	2	1	23	8	0	1·50
September,	9	0	0	1	13	2	3	2	23	7	0	1·80
October, .	10	1	0	2	12	1	1	4	15	16	0	4·11
November,	10	0	0	1	8	2	7	2	12	18	7	2·90
December,	8	2	0	3	11	1	4	2	14	17	21	2·26
	102	15	7	20	133	15	39	35	231	135	103	28·82

The results contained in the above tables, are derived from three daily observations, made at sunrise, 1 P. M. and 9 P. M.

The warmest day in 1852 was June 15th, which averaged 81½°; and the greatest heat in the shade was 97° on the 16th of June, at 2 P. M. The coldest day was the 20th of January, which averaged 5½° below zero; and the greatest cold was −17° in the evening of January 14th. The mean temperature of the year was about 0·11° colder than the average annual temperature of the preceding fourteen years, and 0·23° warmer than 1851. The mean height of the barometer was 0·05 in. less than in 1851. The range of the thermometer was 0·05° greater, and of the barometer 0·20 in. less than in 1851.

The fall of water, in rain and snow, was 3·25 inches less than the mean annual fall in the preceding fourteen years, and three inches less than in 1851. The whole amount of water between the 15th of April and the 3d of June, (7 weeks) was only 0·90 in. The mean fall of water in May for the fourteen years preceding 1852, was 3·07 in., and the smallest quantity in May in any one of those years was 1·55 inches, in 1842. The greatest fall of water in any one month, in the fifteen years ending with the year 1852, was 8·11 inches in October, 1850.

The fall of snow in 1852 was 32 inches more than in 1851, and 5 inches less than in 1850. During the year there were 54 days of tolerable sleighing in Burlington and vicinity, thirty-two days less than last year. The broad part of Lake Champlain, opposite Burlington, froze over January 18th, and broke up April 19th, but was not clear of ice through its whole length till the 3d of May, when the Line Boats commenced running. The water of the lake was highest on the 12th of May, being then 1 foot 8 inches below extreme high-water mark, and it was lowest on the 4th of October, being then 7 feet 9 inches below high-water mark—change of level of the lake in the year 6 ft. 1 inch. The extreme change of level has not been known to exceed eight feet.

Robins were seen the 16th, Blue Birds the 17th, and Song Sparrows the 30th of March. Red-winged Blackbirds were seen the 8th, and Barn Swallows the 30th of April. Trailing Arbutus in blossom April 25th, and Liverwort the 29th. In May blossoms opened as follows: the White Elm the 3d, Red Maple the 6th, Gooseberry 13th, Currants 16th, Red Plum 18th, Plums and Cherries 20th, Siberian Crab-apple 23d, Pear 25th, Common Apple 28th. The Summer Yellow Bird appeared the 5th, Baltimore Orioles the 7th, Bobolinks the 10th, and May Beetles the 21st of May.

The Aurora Borealis was observed on 35 different evenings in the course of the year, the most remarkable of which was on the 19th of February.

The temperature of the water of Lake Champlain, at the depth of 125 feet, when the whole surface of the lake was covered with ice, was 34½° on the 5th of April. This was after the rivers flowing into the lake had broken up, and the temperature of the water where the examination was made, had doubtless been reduced by the ice-cold water brought in by the rivers. The general temperature of the water of the lake, after the ice had disappeared and the waters had been thoroughly agitated by the winds, was, on the 23d of April, 36½°.

ART. XLVI.—*Some Account of the Proteus anguinus*; by JNO. C. DALTON, JR., M.D. With a Plate.

IN the Austrian province of Carniola there are a large number of grottoes, the two most remarkable of which are in the immediate vicinity of Adelsberg, a small post-town, about thirty-five miles inland from Trieste. The larger of these, which is the only one usually visited by travellers, and which is justly celebrated for the extent of its passages, and for the elegance and variety of its stalactites, has its entrance on the side of a hill, about fifteen minutes' walk from the village. It is called by the inhabitants the "Grotto of Adelsberg." A small stream flows into its mouth, but disappears after a short distance through one of the numerous chasms which open into the principal passage. The grotto penetrates the hill in a nearly horizontal direction, and can easily be followed for a distance of one to two miles. It has also been explored for nearly twice that distance, but the passage is difficult and dangerous, and its termination has never yet been reached. In the waters of this cavern there are found occasionally a few crabs and fishes, of the same species as those met with outside, and which have been carried in by the stream that enters at its mouth. There is, however, another grotto, situated about a mile farther from the town, called the "Magdalena Grotto," the waters of which contain the curious species of reptile known as the "Proteus anguinus." This is the only place in the vicinity of Adelsberg where the animals are met with; and though they exist also in other parts of Carniola, they are more abundant in the Magdelena Grotto than elsewhere.

Unlike the "Adelsberg Grotto," this cavern receives no stream at its mouth, and penetrates the hill in a steep downward direction, instead of horizontally. After descending, for about fifteen minutes, by an exceedingly rough and irregular passage, partly rocky and partly covered with soft mud, the visitor comes to a pool of still water, varying from 12 to 18 feet in depth, according to the season, beyond which the cavern cannot be explored. It is in this pool that the Proteus is met with. The water apparently communicates with that of the Adelsberg Grotto; as it is always turbid when the latter is so, and vice versâ. Both caverns are, of course, perfectly dark, and can be explored only with torches. The temperature, in the latter part of August, was about 40° to 50° F., and probably does not vary much throughout the year. It is certain, at least, that in winter it is much higher in the interior of the grotto than outside. The Proteus is taken in small hand-nets by the peasants, who watch for the animal as he lies almost motionless near the bottom of the pool, and capture him by a sudden motion of the net. They are not very abundant, however, and as they can be taken only when the water is perfectly clear, it is seldom that more than 15 or 20 are obtained during the course of a year. The animals should be kept afterward in obscurity, and at a temperature as nearly as possible resembling that of the grotto. It is necessary, also, to change the water in which they are kept regularly every day. With these precautions it is said they may be preserved alive for an indefinite length of time. I have myself kept one of them for several weeks without giving it any food, and at the end of that time it was as active, and nearly as well-conditioned as ever; only the branchiæ had become somewhat smaller. I am told by Mr. Fitzinger, the Superintendent of the Department of Reptiles in the Vienna Zoological Museum, that they have been kept at the Museum for over six years, without any other food than the organic matters usually existing in fresh water.

It is very commonly believed that the Proteus is found only in the Magdalena Grotto. This, however, is an error; as it appears, by a report of Mr. Fitzinger's to the Imperial Academy of Sciences, in Oct. 1850, that there are no less than thirty-one different localities in which the animal is said to have been found since it was first discovered in 1751. Mr. Fitzinger, himself, has seen specimens from eleven different localities. Of these the Magdalena Grotto supplied much the greater number, viz.: 312 out of 479. The reporter states that, in almost every instance, the animals coming from different grottoes, present such striking peculiarities in size, color and shape, that they cannot be considered as belonging to the same species. Accordingly, he rejects the the old name of Proteus Anguinus and adopts instead the generic name "Hypochthon." In this genus he comprises seven different species, as follows:

Hypochthon Zoisii,
" Schreibersii,
" Freyeri,
" Haidingeri,
Hypochthon Laurentii,
" xanthostictus,
" Carraræ.

Six of these species are found in various grottoes of Carniola, and the seventh in Dalmatia. Two different species never exist together in the same locality, though sometimes the same species is found in more than one grotto. One of the principal marks of distinction is their size; the maximum length of the different species varying from $9\frac{1}{3}$ to $11\frac{4}{5}$ inches. The tint of the skin is in some species more rosy, in others yellowish. The head is pear-shaped, triangular, or more globular in form. The eyes, also, are more distinctly visible in some species than in others, and vary somewhat as to their situation.

The living specimen from which the drawing for the plate was made (fig. 1) came from the Magdalena Grotto. It belongs to the smallest of the species described by Mr. Fitzinger, viz.: the H. Laurentii. Specimens of two other species, the H. Haidingeri and H. Freyeri were obtained afterwards at the Vienna Museum for purposes of dissection.

The body of the animal is cylindrical, like that of an eel, with its posterior portion compressed laterally into a kind of vertical membranous fin. There are four extremities, the anterior three-toed, the posterior two-toed. The posterior are considerably smaller and more feeble than the anterior. The first circumstance which strikes the notice of the observer is the almost entire absence of color, and the transparency of the tissues, which allow the cutaneous and subcutaneous vessels, and even the veins and arteries of the extremities to be perceived without difficulty. The heart can be distinctly seen through the skin, at the anterior part of the neck, beating 48 to 50 times per minute. The dark color of the liver, also, shows through the integument very plainly on the under surface of the abdomen. The whole aspect of the animal reminds one very strongly of the fœtal condition of the higher vertebrata, particularly about the extremities, where the transparency of the integuments shows to best advantage. Notwithstanding, however, its delicacy and apparent feebleness, its motions are occasionally very rapid and energetic. They consist of swift undulating movements of the eel-like body and tail. The limbs are nearly useless during rapid progression, and remain almost motionless, applied to the sides of the body. It is only in the slow motions of crawling and turning, that the extremities are used, and then only in a feeble and imperfect manner. The gills, three in number on each side of the neck, are in the form of long tufts; each principal stem being divided into six or seven branches, and these again subdivided into fine twigs. When the Proteus is in rapid motion, they become distended with blood, and of a bright scarlet color, contrasting finely with the light yellowish, indefinite hue of the rest of the body. In a state of rest, however, they are often perfectly pale, like any other part of the surface. The animal occasionally lifts its head above water and takes in air by the mouth or nostrils, which, after remaining sometime in the lungs, is expelled through the branchial fissures in the sides of the neck. Notwithstanding this frequent inspiration of air, however, and the large size of the lungs, the pulmonary respiration is a very imperfect one and altogether secondary to the branchial. It is said that in a moist and cool place, as, e. g., on the floor of the Magdalena Grotto, the Proteus can live many hours, carrying on its respiration by the lungs and through the skin only; but in a warm apartment it expires in a few minutes after being taken out of the water; particularly if the skin is wiped dry, as I have myself ascertained by trying the experiment. Over the whole surface of the skin, from the anterior part of the head nearly to the end of the tail, there are minute punctiform openings, the orifices of cutaneous follicles, which exude an abundance of transparent colorless mucus. The peritoneal cavity is also filled with a similar exudation.

There are but few peculiarities about the skeleton. The bodies of the vertebræ are articulated to each other by concave surfaces as in the fishes, instead of one of the articulating surfaces being concave and the other convex, as is the general rule among reptiles. The anterior extremities consist of a cartilaginous clavicle and scapula, fused into a single piece, a humerus, radius and ulna, three carpal pieces, and three digits, the two inner ones of which have three phalanges each, and the outer one, which is shorter, only two. The posterior extremities are supported by a simple pelvic ring, resting against the sides of the vertebral column. They are composed of a femur, tibia and fibula, a tarsus composed of three pieces, precisely similar to those of the carpus, and two digits of three phalanges each. All these parts are entirely cartilaginous, or so slightly ossified that it is difficult to be sure whether there is any true bony formation or not. The snout is rather broad and thick. The nostrils open on the under surface of the upper lip, as in *Lepidosiren Paradoxa*. They are continued into a cylindrical, membranous canal, something less than a third of an inch long, situated in the thickness of the lip. There is a long row of fine, sharp, conical teeth in both upper and lower jaw; and in the upper, there is also a second much shorter row, in front of the first. The tongue is erroneously stated by R. Wagner (Comp. Anat. Vertebrata) to be wanting. It is, on the contrary, very easily seen; about one-eighth of an inch long, but consisting only of mucous membrane and adipose tissue. The animal has the vertical stomach and short intestinal canal of the allied genera. The anus is a longitudinal slit, just behind the junction of the posterior extremities with the body. The liver is a long, lobulated organ, wrapped round the stomach and upper part of the intestinal canal, and extending nearly two-thirds the whole length of the abdominal cavity. The heart, enclosed in a pericardium, is composed of a single auricle and ventricle. The arterial trunk arising from the ventricle is partially converted into a double canal by an imperfect longitudinal partition. It sends off, on each side, three branchial arteries, and the returning branchial veins unite immediately below the situation of the heart, to form a single descending aorta. The lungs are simple, elongated. thin, membranous sacs, secured by a fold of peritoneum against the posterior abdominal wall, and somewhat unsymmetrically developed. The left runs down, from its opening into the œsophagus, nearly three-quarters the whole length of the abdominal cavity; the right but little over one-half the length. The blood globules of this animal have been long known to be remarkable on account of their large size.

They can be easily found almost unaltered in the blood vessels, and particularly in those of the gills, even in specimens which have been kept for a long time in spirit. They are of a flattened oval shape, like those of the frog, with a central, white, granular, roundish nucleus, also somewhat flattened. The length of the globules varied, in the specimen examined, from ·0016 to ·0023 inch. The breadth is usually ·0013, and the thickness ·0003. As this last measurement is exactly the diameter of the human blood globule, some estimate may be made of the difference between them. In fig. 4 the blood globules of human blood, of the frog, and of the Proteus (*a*, *b*, and *c*) are magnified in the same proportion, in order to show their relative sizes. The muscular fibres of the body are also very large, and very distinctly striated. Their diameter varies from ·0019 to ·0036 inch. The nerve-fibres were not remarkably large, those from the facial measuring only ·00027 inch in diameter.

The two most interesting peculiarities of the animal, taken in connexion with its subterranean mode of life, are the colorless condition of its skin, and the imperfect development of its visual organs. At first, the eyes seem to be altogether wanting; but on close examination, they may be discovered in the recent state, as two minute blackish points, situated about the junction of the anterior and middle thirds of the head (fig. 1). When the animal has been preserved in spirits, it is sometimes impossible to distinguish them until the integuments have been removed. They are then found lying immediately beneath the skin, imbedded in a small quantity of adipose tissue (fig. 2). In an individual measuring $8\frac{7}{8}$ inches in length, the eyeball was $\frac{1}{50}$th of an inch in diameter; and the optic nerve, just before joining the globe, $\frac{1}{362}$nd of an inch. Notwithstanding its minute size, however, the eye is sufficiently well developed as to its structure. The sclerotic is covered with brownish spots, mostly hexagonal in shape, and which are more thickly crowded and deeper in shade just at the margin of the cornea, where they form a blackish ring (fig. 3). The crystalline lens is globular, and $\frac{1}{145}$th of an inch in diameter. There were some appearances of a nearly colorless iris, lying behind the cornea, but the parts were so minute that I did not succeed in ascertaining its existence by dissection. The brain is pretty well developed, though less so than in other allied genera; and notwithstanding the imperfect condition of the eyes, the lobes which, in the brain of reptiles, are usually considered as representing the Tubercula Quadrigemina, are of very considerable size. The brain of the Triton cristatus, another naked Amphibian, with large well developed eyes, differs from that of the Proteus simply in being rather larger in comparison with the size of the animal, and in having a somewhat greater proportional development of the hemispherical lobes. The following are the longitudinal measurements of the brain of a Triton cristatus, 6⅓ inches long, and that of a Proteus anguinus, 8⅞ inches long:

	Triton.	Proteus.
Hemispherical lobes,	5 millimetres.	4½ millimetres.
Tubercula Quadrigemina,	2½ "	2½ "
Cerebellum, . .	1½ "	1½ "

The two brains could hardly be distinguished from each other, except for the fact that the olfactory nerve in the Proteus runs forward for some distance as a trunk along the inner side of the membranous olfactory canal, while in the Triton it breaks up into branches immediately on leaving the anterior extremity of the brain (fig. 5).

It will be seen that the suppression of the visual organs in these animals is not, by any means, complete. There are, however, other creatures existing in the same localities with the Proteus, in which the eyes are altogether absent. Two species of Crustaceans are found in the caves of Carniola, viz: Palæmon anophthalmus and Titanethes albus, both of which are colorless, diminutive in size (not more than one inch long), and, so far as they have been examined, entirely destitute of eyes. They are supposed by some to be the natural food of the Proteus. I am informed by Mr. Kollar, of the Vienna Zoological Musuem, that a species of spider, entirely blind, has also been discovered in the same caverns.

There is much resemblance, in regard to the condition of the eyes, between the Proteus and Lepidosiren Paradoxa. In the two specimens of Lepidosiren, dissected by Prof. Bischoff, and described by him in a monograph on the subject, the eyes were "hardly a line in diameter," though one of the animals measured over three feet in length. The opening of the eyelids is wanting, also, in Lepidosiren as in Proteus, and the eyeball is completely covered by the integument. So little is known, however, of the mode of life of Lepidosiren, that it is impossible to determine whether the cause of the imperfection be the same in both animals.

Very little is yet known with regard to the mode of reproduction of the Proteus; and, particularly, it is altogether uncertain whether the animals are oviparous or viviparous. Dr. Joseph Hyrtl, Professor of Anatomy at the University of Vienna, states that he has found, at the extremity of the oviduct in the Proteus, a gland which exists elsewhere only in the oviparous species of the naked Amphibia; so that the Proteus is probably also oviparous. But nothing more definite has been discovered. One German observer (von Schreibers) endeavored to ascertain this point by examining specimens of Proteus, taken from their caverns at every season of the year; but, according to Herr Fitzinger, he only succeeded in finding the ovaries unusually developed in a few instances. H. Fitzinger, himself, has met with the ovaries in a state of active development in only one instance; and up to the present time, according to him, neither ova nor embryos have ever yet been discovered in the oviducts.

The female generative organs consist of two elongated, sacciform ovaries, situated at the posterior part of the abdomen, directly in front of the kidneys. In the specimen measuring $8\frac{7}{8}$ inches total length, in which the generative organs were in a state of quiescence, the right ovary was 0·98 of an inch long,—the left somewhat smaller. The cavity of the organs was lined by a mucous membrane, beneath which were to be seen the whitish, globular, nearly transparent ova, varying in diameter from $\frac{1}{70}$th of an inch downward. The oviducts were a pair of slender and perfectly straight tubes, which, commencing by a wide aperture, at some distance anterior to the ovaries, and running down on the outer and posterior aspect of these organs, opened into the cloaca, just above the orifices of the ureters.

In another specimen, however, obtained at the Vienna Museum, the organs were in a high state of development. The right ovary was 1·75 inches, the left 1·64 inches long, and they contained, together, 66 roundish, opaque ova, of a deep yellow color, and evidently just ready to be discharged. Their average size was a little less than $\frac{1}{7}$th of an inch in diameter. The oviducts were much larger than in the other specimen, and exceedingly contorted, so that they must have attained two or three times their ordinary length. None of the ova, however, had yet left the ovaries, so that nothing new could be learned with regard to the question of viviparity.

Art. XLVII.—*On Ericsson's Hot Air, or Caloric Engine;* by William A. Norton, Professor of Civil Engineering in Yale College.

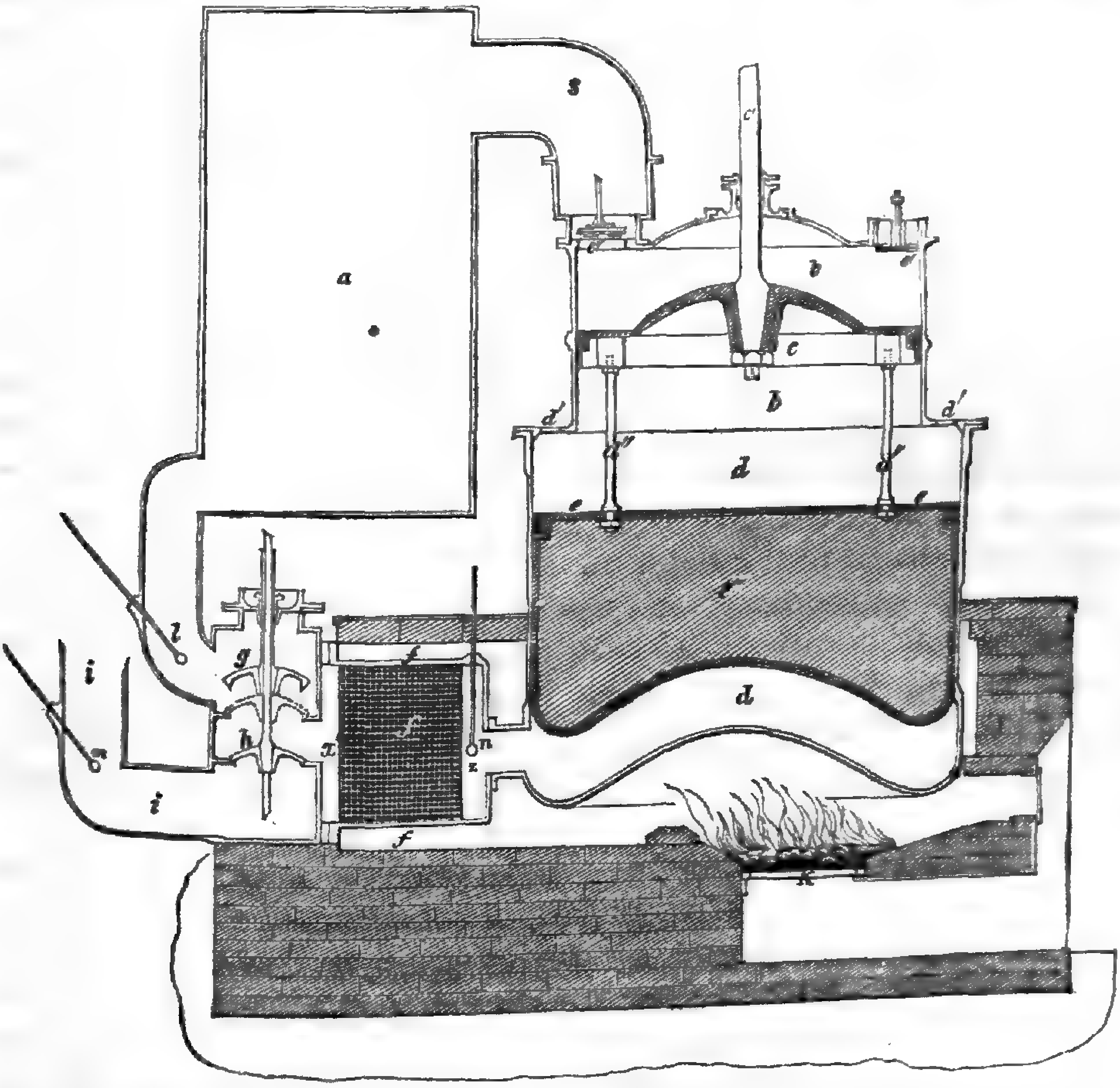
A short notice of this new engine, containing a description of its construction and working, was published in the last number of the Journal; it is proposed, in the present communication, to enter upon a somewat extended discussion of its theory and performance. The notice referred to describes the stationary test-engine of 60 horse-power, which was set up in the manufactory of Messrs. Hogg & Delamater, New York; in the present inquiry I shall confine my attention chiefly to the enlarged and modified form presented in the engines of the caloric ship Ericsson.

These engines consist of four large double cylinders, "standin a fore-and-aft line; two before and two abaft the shaft of the paddle wheels, and working in pairs upon it." Each cylinder is double, the two cylinders being placed one above the other. The lower one, which is the larger of the two, is called the working cylinder, and the other the supply cylinder. The working cylinder is entirely open at the top, and the supply cylinder at the bottom. The pistons which play in the two cylinders are connected by eight strong iron columns, and move up and down together; the length of the stroke is therefore, of necessity, the same for each, viz: 6 feet. For the sake of distinction, the piston in the working cylinder is called the working piston, and the piston in the supply cylinder the supply piston. Underneath each working cylinder is a furnace, which heats the air in this cylinder beneath the piston, and by thus increasing its expansive force, furnishes the motive power of the engine. The expansive force of this heated air drives the working piston up, and with it the supply piston. During the ascent the air above the supply piston which is compressed before it passes through a communicating pipe into the working cylinder, and receiving an accession of heat keeps up the ascensional force. When the pistons have reached their highest point, a valve is opened by the machine, which establishes a free communication between the compressed and heated air under the working piston and the external air; it flows out, and the two connected pistons descend by their own weight. It is to be observed, however, that the mechanical effect of this descending weight is but a compensation for the diminution of mechanical effect produced by the same weight in the ascent, and that the weight of the pistons therefore forms no part of the real motive power of the engine.

Confining our attention to the pair of double cylinders posited on either side of the main shaft, in the vacant space between the working and supply cylinders is placed a horizontal working beam, turning upon a shaft lying between the two double cylinders. One of the supply pistons is connected with one end of this working beam and the other with the other end; by means of links and connecting rods: and so, by the alternate action of the two working pistons, a reciprocating movement is communicated to the working beam. It will be seen therefore, that *one double cylinder*, with the necessary appurtenances, *constitutes a single acting engine*, and that *each contiguous pair of double cylinders*, standing on either side of the main shaft, by the connection of their pistons with the opposite ends of a working beam, *form a double acting engine;* that they accomplish the same end as one double acting steam engine.

The shaft of the paddle wheels of the Ericsson is, accordingly driven by two double acting engines; one before and the other abaft the shaft. Each of these engines has its separate working beam. The power is transferred from each of these working beams to the shaft, (which, it is to be observed, is considerably elevated,) by means of a connecting rod passing from the nearer end to the crank of the paddle-shaft. The two connecting rods are attached to the same crank-pin; and the relative position of the shaft and working beams is such that each of the connecting rods has a mean deviation of about 45° from the vertical position, and when one rod is passing the dead centre the other is acting upon the shaft with the maximum leverage.

From what has been stated, it will be seen that in studying the essential theory of the new engine, we may confine our attention to one of the double cylinders with its accompanying mechanical arrangements, which taken together form one single acting engine. The essential parts of this engine are shown in the annexed diagram, which is a copy of Ericsson's representation of the stationary engine.* These are, respectively, the double cylinder, with the pistons and piston rods; the furnace; a large vessel, communicating by pipes with the top of the supply cylinder and the bottom of the working cylinder, called the *Receiver;* and a piece of apparatus placed in the lowermost of these pipes, called the *Regenerator.* The working piston in the engines of the Ericsson, has a diameter of 14 feet, and the supply



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* Reduced from a plate in Appleton's Mechanics Magazine for February.

piston a diameter of 11 feet 5 inches. The ratio of the areas of these pistons, and therefore also the ratio of the volumes of the two cylinders is as 3 to 2. The working piston is six feet deep, and concave underneath to fit the cylinder-bottom. The top and bottom, as well as the sides, are of iron, but the space between them is filled with gypsum and charcoal, non-conductors of heat. The packing of the piston is at the top. The working cylinder is of necessity prolonged six feet below the position of the top of the piston when at its lowest point, thus forming a large vessel, called the heater, or heating chamber, into which the air passes from the receiver. By this arrangement the packing at the top of the piston never comes into contact with any portion of the cylinder that is touched by the hot air. The grate of the furnace is five feet below the apex of the dome-shaped cylinder-bottom. Anthracite coal is used, and acts by its radiant heat alone. The supply cylinder is merely a great condensing air-pump, which forces fresh air into the receiver, to be thence transmitted to the heating chamber under the working piston. The supply piston is furnished with thirty-six self-acting valves, which open upwards, and through which the air is admitted into the cylinder in the descending stroke of the piston. During the ascending stroke these valves remain closed, and the compressed air opens another set of valves at the top of the cylinder, and flows along the connecting pipe into the receiver. These two sets of valves may be called respectively, the *outlet* and the *inlet* valves. The valve arrangement represented in the diagram is a little different; both the outlet and inlet valves are at the top of the cylinder. e' is an inlet, and e'' an outlet valve. The air-receivers of the four double cylinders communicate with each other by connecting pipes, and thus form, in connection with the several communicating pipes, one common receiver, of so large a size, that, as it is asserted, the elastic force of the compressed air remains very nearly the same, in the working of the engine. This receiver is provided with a guage. The communications between the receiver and the heater, and between the heater and the external air are closed by two puppet-valves. These valves are shown in the diagram at g and h. The one I will call the *upper*, and the other the *lower* valve. The thermometers at l, n, m, serve to indicate the temperature of the entering and escaping air. When the working piston reaches its lowest point, that is, is nearly in contact with the cylinder bottom, the upper valve is opened by the machine, the compressed air rushes from the receiver, through the regenerator into the space underneath the working piston, and the piston is forced up. At two-thirds of the stroke this valve is closed, and the heated air acts expansively to the end of the stroke. The lower valve is now opened, and the same body of air escapes through it into the vertical pipe *i*, which communicates with the external air; passing again through the regenerator, on its exit.

The Regenerator is an admirable contrivance of Captain Ericsson's for abstracting the heat, or the greater portion of it, from the escaping air and restoring it again to an equal body of air entering the cylinder, to repeat the work performed by the air which has just escaped; that is, for employing the same amount of heat over and over again. The regenerator consists of a large number of disks of wire-netting, placed side by side, and in a vertical position, in a marginal frame by which they are held very nearly in contact with each other, (see the diagram.) Each disk is six feet high and four feet broad, the wire of which it is made is $\frac{1}{16}$th of an inch in diameter, and there are tens of thousands of minute meshes in the whole extent of the disk. The number of meshes in all the disks, added to the equal number of interstitial spaces between the disks, make up, it is stated, over 20 millions of minute cells through which the air passes and repasses, on its way to and from the working cylinder. In this way it is brought into contact with several thousand square feet of metallic surface, and parts with or imbibes heat almost instantaneously. It is stated that Captain Ericsson estimates the time occupied by a particle of air in traversing the regenerator at about $\frac{1}{30}$th of a second, and that this small interval of time suffices for the transfer of some 400° of heat from the escaping air to the wire, or from the wire to the entering cold air. The clear opening for the passage of the air through the regenerator is about twelve square feet.

We are told that the escape or waste air deposits all of its heat, with the exception of about 30°, in the regenerator, the thermometer at *m* never standing more than 30° higher than that at *l*. Ericsson estimates that in the case of the stationary engine, the amount of fuel wasted in the process of transfer, was only *two ounces* of coal per hour per horse-power, while the amount wasted by the radiation of the heated parts was about nine ounces per hour per horse-power, and the entire consumption about 11 ounces. (See last number of this Journal, p. 286.) But it should be observed that his calculation involves the supposition that the estimated horse-power (60) was realized in the actual working of the engine. We shall be better able to judge of the probability of this, after we have considered the details of the performance of the engines of the Ericsson.

After the engine has got into full operation, and the regenerator has reached its normal condition, there is a great difference between the temperatures of the inner and outer surfaces of the regenerator. We are told that in the case of the regenerator of the stationary engines this difference was never less than 350°. The explanation is found in the fact that the heated air, on its escape through the regenerator, must undergo a continual diminution of temperature, as it parts with its heat to the successive disks of wire-netting, and on the other hand the entering cold air, on passing through the successive disks, which are of a higher and higher temperature, will tend to lower the temperature of each one of these disks, and at the same time to increase the difference of temperature between the outer and inner surfaces of the regenerator, and thus to compensate for the tendency to equilibrium of temperature produced by the flow of heat from the inner towards the cooler outer surface. For, while it will reduce the temperature of the outer surface, if the regenerator has sufficient thickness, nearly to an equality with the temperature of the external air, the inner surface being exposed towards a highly heated enclosure will be less affected. It is to be observed that the temperature of the external surface of the regenerator cannot at any time be greater than that of the air escaping through the pipe *i*, and that the temperature of the internal surface can never be less than that of the air issuing from this surface, on its passage into the working cylinder, or rather, heating chamber.

The preparation necessary for starting the engine consists in "keeping up a slow fire in the furnaces, for about two hours, until the various parts contained within the brick work shall have become moderately heated, and then charging the receiver with air by means of a hand-pump," until the guage shows a pressure of about eight pounds above that of the external air. The upper valve, *g*, is then opened by a starting bar, and the compressed air flows into the working cylinder, and begins the work of raising the piston.

We are now prepared to inquire into the

THEORY OF THE MOTIVE POWER OF THE ENGINE.

I will first state a few principles which it is important should be kept in view.

1. The expansive force of the heated air under the working piston must be somewhat less than that of the compressed air in the receiver; otherwise the air in the receiver would have no tendency to flow from it into the heating chamber. The difference may not amount to more than a few ounces; it depends upon the obstructions that exist to the free flow of the air and the relative size of the aperture of communication and heating chamber.

2. When the air is flowing from the supply cylinder into the receiver its elastic force must exceed that of the air in the receiver; for the additional reason, beside that just stated, that the valves in the supply-piston would close if no such difference of pressure existed.

In seeking to determine the power of the engine I shall however disregard the inequality of pressure and suppose the expansive force of the air to be the same in the working and supply cylinders as in the receiver, so long as the communications between them are open.

3. Since the two connected pistons are of unequal size, and the elastic force of the air pressing upon them the same or nearly the same, the entire upward pressure exceeds the downward pressure, and the two pistons are urged up with a force equal to the difference of these pressures. This statement is here made with respect to the actual pressures subsisting when the communications are open. We shall see hereafter that it might also be made in regard to the mean effective pressures throughout the stroke.

4. In the engines of the Ericsson the cut off is introduced at the $\frac{2}{3}$ stroke, and therefore the space underneath the working piston into which the air is admitted from the receiver, before the cut off valve is closed, is equal in volume to the interior of the supply cylinder. It will soon be seen that this is in accordance with a general principle, the adoption of which is essential to the most efficient operation of the present form of engine.

5. When the engine has reached its permanent working state the quantity of air admitted into the working cylinder each upward stroke of the piston, cannot exceed the quantity forced into the receiver, from the supply cylinder, during the same interval. In fact it must be less, by reason of the waste from *leakage* and *clearance*.

Now it will be perceived that if this quantity of air, after being admitted into the working cylinder, as just supposed, retained the same temperature, its elastic force would be the same as that of the external air (15 lbs. say, per square inch); since the same quantity originally filled the supply cylinder, at this pressure. But if we suppose its temperature to be elevated 480°, or thereabouts, by the heat derived from the regenerator and the heating chamber, its elastic force would be doubled, or amount to 30 lbs. per square inch. To realize this supposition the compressed air in the receiver must therefore have an expansive force of over 30 lbs., or 15 lbs. above the atmospheric pressure. If the working temperature in the lower cylinder were 384° above the temperature of the external air instead of 480°, then the pressure in that cylinder, and of necessity therefore in the receiver, would be 12 lbs. above the atmospheric pressure, (i. e. $\frac{384}{480}$ths of 15 lbs.) It will be seen then that the working pressure in the receiver and the working temperature in the principal cylinder are necessarily connected together—that the one determines the other.

It is here supposed that there is no leakage or clearance, but the fact is otherwise; and therefore the quantity of air admitted into the working cylinder, each ascending stroke, is less than that which is expelled from the supply cylinder into the receiver. If we suppose the pressure in receiver to be 8 lbs. above the atmospheric pressure, and that the leakage and clearance, at this pressure amounts to ¼, then ¾ of the air furnished by the supply cylinder will enter the working cylinder, and its elastic force, for the ⅔ stroke, would be reduced to 11¼ lbs. (¾ of 15 lbs.), by the expansion, if the temperature remained unchanged, but the 480° of additional heat will augment this to 22½ lbs., or 15 lbs. + 7½ lbs. Now 8 lbs. above the atmosphere, is the actual working pressure of the engines, we may conclude therefore, that if the working temperature is 480° above the atmospheric temperature or a little less, the waste from leakage and clearance, during the double stroke, must amount to nearly ¼. The actual working temperature is undoubtedly less than this, but how much I have not been able to ascertain with certainty. The actual leakage is therefore less than ¼, but its exact amount cannot at present be determined. According to the newspaper accounts the working temperature, on the trial trip, was about 450°, or 418° above the temperature of the air (taken at 32°). This would make the waste, from leakage and clearance, about ⅕. It undoubtedly lies between ¼ and ⅕.

Working at a given temperature, and with a given cut off, the leakage will determine the working pressure. To show this, suppose the elevation of temperature to be 480°, and the leakage ¼ at a pressure of 8 lbs., shown by the receiver-guage; then at 12 lbs. pressure the leakage, if we disregard the clearance which is comparatively small, would be ⅜ths, and the elastic force of the air in the working cylinder would be reduced from 7½ lbs. to 3¾ lbs. If the communications remained the same, so great a difference of pressure between the receiver and cylinder could not be realized; an additional quantity of air would flow out of the receiver, and this would go on for each successive stroke until the pressure in the receiver was reduced to 8 lbs., or thereabouts, when the pressure in the cylinder would be 7½ lbs., and the engine would be nearly in its permanent working condition.

From this cause, (viz., the leakage,) mainly, as it would seem, the expected pressure of 12 lbs. has not been obtained in the working of the engines of the Ericsson. This is in fact the reason assigned by the builders of the engines, for the fact that no higher pressure than 8 lbs. has yet been realized.

There is another mode of presenting the theory of the motive power of the caloric engine. Suppose that the constant pressure in the receiver is 15 lbs. + 15 lbs. On this supposition air will begin to pass from the supply cylinder into the receiver, at the end of the ½ stroke, or thereabouts, and will continue to flow to the end of the stroke, at a pressure a little above this. At the end of the ½ stroke of the supply piston the body of air which originally filled the supply cylinder at 15 lbs. pressure, will occupy one-half the space at 30 lbs. pressure. Now, while the communication between the receiver and the working cylinder continues open, that is during the $\frac{2}{3}$ stroke, if we disregard the leakage, &c., the same quantity of air, at the same pressure of 30 lbs., will flow from the former to the latter. It is capable of filling a space equal to one-half of the supply cylinder, or what amounts to the same, one-third of the working cylinder, at the same temperature, without any change of pressure; therefore in expanding to fill two-thirds of the working cylinder its expansive force will be reduced to 15 lbs. To compensate for this it is only necessary that its temperature, as fast as it flows in, should be elevated 480°, when its expansive force will be retained at 30 lbs.

A similar explanation may be given for any other supposed pressure and temperature, and the question of the leakage may be considered from this point of view.

It has been stated that the cut off, whatever may be the relative size of the two cylinders, should be so adjusted that the portion of the working cylinder into which the air is admitted while the valve remains open, will be equal in volume to the whole supply cylinder. To show this, we will at first leave the leakage out of view, and denote the fractional part of the stroke answering to the cut off supposed, (in the present engines $\frac{2}{3}$) by *a*, and a larger fraction of the stroke, answering to a different cut off, by *b*. Let *b* be *n* times greater than *a*. Now, if we conceive the fractional cut-off-stroke to be less than *a*, the actual working pressure remaining the same, the mean effective pressure, for the whole stroke, will be less than when *a* is used. If, on the other hand, it be made greater, (as $b=na$), the body of air which originally filled the supply cylinder, at 15 lbs. pressure and 32° temperature, on entering the working cylinder, will expand *n* times, and its working force will be $\frac{15}{n}\times 2$ (supposing working temperature to be $480^\circ+32^\circ$); whereas, for the cut off *a* the force will be 15×2, and in the subsequent expansion from *a* to *b*, the mean force throughout the fractional stroke *b* will be greater than $\frac{15\times 2}{n}$, since this will be the actual force after the expansion to *b*.

The same will be true if we take the leakage into account; for suppose the leakage to reduce the pressure of the air that fills *a*, before it is heated, to $\frac{15}{m}$, then when heated 480° the pressure becomes $\frac{15}{m}\times 2$, which we will put equal to *k*. Now, if we suppose, as before, the cut off to be increased from *a* to *b*, the force

k will be reduced to $\frac{k}{n}$; but the mean effective pressure for the same fractional stroke b, when the cut off a is used, will be greater than this, and the actual pressure after the expansion to b, will be $\frac{k}{n}$. So that the constant pressure for the b cut off is equal to the pressure for the a cut off reduced by the expansion to b.

It may be well to inquire, in this connection, into the proper relative size to be given to the supply and working cylinders to obtain the greatest amount of motive power from the engine. Let $A =$ area of supply piston, and $x =$ ratio of working to supply piston; then, by what we have seen, the portion of the stroke during which the air is flowing into the working cylinder, and acting with its full constant pressure is equal to $\frac{1}{x}$. Calling this pressure per square inch, P, the following proportion gives us the mean effective pressure (p) on working piston, for the whole stroke, viz., $x : \text{hyp. log. } x+1 : : \mathrm{P} : p = \frac{\mathrm{P} \log. x + \mathrm{P}}{x}$. The mean effective upward pressure upon the whole piston will therefore be expressed by $\frac{\mathrm{P} \log. x+\mathrm{P}}{x} \times \mathrm{A}x$, or $\mathrm{P.A} \log. x + \mathrm{P.A}$. The downward pressure on the working piston $= 15 \text{ lbs.} \times \mathrm{A}x$, and hence the resulting effective pressure $= \mathrm{P.A} \log. x + \mathrm{P.A} - 15\mathrm{A}x$. With the aid of the differential calculus, we find this expression to be a maximum when $x = \frac{\mathrm{P}}{15}$, $\left(\text{more accurately } \frac{\mathrm{P}}{14 \cdot 7}\right)$; from which it appears that the engines will have the greatest possible power, at any given working pressure, when the cut off, taken inversely, and the ratio of the volumes of the two cylinders, are each equal to the working pressure per square inch, divided by the atmospheric pressure (15 lbs). Accordingly the ratio of the bulks of the cylinders ought to vary with the working pressure used. When this pressure is 8 lbs. above the pressure of the atmosphere, the cubical content of the supply cylinder ought to be $\frac{648}{1000}$ of that of the working cylinder, and the portion of the stroke from the commencement at which the air is cut off, the same. The actual ratio of the cubical contents of the cylinders of the engines of the Ericsson is $\frac{665}{1000}$, ($\frac{66}{100}$ nearly), and the fraction of the stroke at which the air is cut off is said to be about $\frac{63}{100}$.

If a pressure of 12 lbs. instead of 8 lbs. were used, the same ratio ought to be $\frac{55}{100}$. This would make the radius of the working piston 15·4 feet. It was Ericsson's original design that it should be 16 feet.

Let us see now how the *power of the engines* of the caloric ship is to be determined. The actual pressures upon the two pistons are the same, or nearly the same, while the communications are open; the pressure on the top of the supply piston begins at 15 lbs., becomes 8 lbs. + 15 lbs. at the $\frac{2}{3}$ stroke from the end (more accurately $\frac{65}{100}$), and continues the same to the end of the stroke. The air is shut off from the working cylinder at the same fractional part of the stroke, and acts expansively to the end of the stroke. The mean effective pressure per square inch, for the whole stroke, is then the same upon both pistons. It may be found in the usual manner, by the use of hyperbolic logarithms. Multiply this, diminished by 15 lbs., into the difference between the areas of the two pistons, expressed in square inches, and again into the velocity of the piston per minute, and divide the product by 33,000, and the result will be the *horse-power* of one of the engines.

But it is to be observed that the result thus obtained will be somewhat too large, for the following reasons. 1. The actual pressure in the supply cylinder is greater than the pressure in the receiver (8 lbs.), and the actual pressure in the working cylinder is less than this. 2. During the $\frac{1}{3}$ stroke from the commencement, the outlet valves at the top of the supply cylinder remain closed, and consequently the expansive force of the air in the receiver must be somewhat reduced by the flow of air from it into the working cylinder. 3. After the cut off valve is closed, the elastic pressure of the air in the working cylinder during the remaining $\frac{1}{3}$ stroke, must be diminished somewhat by leakage. The effect of this leakage has not hitherto been taken into account.

PERFORMANCE.

There have been two trial trips of the Ericsson, in the New York harbor and bay, and the ship has subsequently made a successful trip to Alexandria and back. On the first occasion, only the inventor, owners and crew were present. The performance on the occasion of the second trip (Jan. 11th, 1853) was witnessed by the members of the New York press, and a few other gentlemen, present by invitation. The results of the trip have been published in all the New York papers, but the different accounts disagree very materially on most of the important points. By personal inquiry and by consulting the most reliable accounts I have endeavored to come as near to the truth as possible. The following are the principal results:

No. of revolutions of wheels per minute, (according to Ericsson), ...	9¼
Same, (according to other most reliable authorities), .	9
Speed through the water, (according to Ericsson),	8½ miles.
" " " " (according to other authorities),	7 "
Working pressure in receiver, per square inch, . .	8 lbs.
Consumption of anthracite coal in 24 hours, . .	6 tons.

The two estimates of the speed through the water are quite different, but the number of revolutions of the paddle wheels, as stated by different authorities, lies between 9 and 9¼. The number of revolutions, about which there is but little disagreement, will enable us to obtain by calculation a pretty close approximation to the speed. For this purpose we have the following data. Diameter of the wheels from centre of pressure to centre of pressure, 30¾ feet; paddles 32 in number, on each wheel, and 10½ feet long by 16 inches deep; dip of the wheels 44 inches. The following quantities were obtained by calculation, viz: number of paddles in water, on each wheel, 7; immersed paddle surface on both wheels, 196 square feet; area of midship section, at 17 feet draft, 520 square feet; ratio of immersed paddle surface to area of midship section, 1 to 2·653; same for steamship Arctic, 1 to 1·662 (see Journal of Franklin Institute for Jan., 1853, No. 1, p. 33); slip of wheels of Arctic, 19·32 per cent. From which we find the slip of the wheels of the Ericsson, on the trial trip, to have been 24·4 per cent. The distance passed over by the centre of pressure of wheels was 9·88 miles per hour. Hence, allowing for the slip, the speed of the ship was 7·47 miles per hour. If we allow for the less oblique action of the paddles in the case of the Ericsson than in that of the Arctic, we find the speed to have been 7·57 miles per hour (the slip of the wheels being reduced to about 23·4 from this cause).

There is some little uncertainty with regard to the area of the midship section. Although I have not succeeded in obtaining the data necessary for an exact calculation of this element, the information furnished me in reference to the model of the Ericsson as compared with that of the steamers of the Collins line, has enabled me to approximate very nearly to a correct result. The rule by which the calculation was made has been tested by trying it upon a large number of ships. It gives results, in almost every instance, a little too small; thus for the Arctic, the result is 662, and the true area is 685. The greater "dead-rise" of the Ericsson may diminish the area, as compared with the Arctic, some 30 square feet; which would make it about 510 square feet. It in all probability, lies between 520 and 500.

If we take it at 500, the slip of the wheels comes out 23 per cent., and the speed of the ship 7·61* miles. In view of all that has now been stated, we may conclude that *the average speed of the Ericsson through the water, on the trial trip, could not have exceeded 7¾ statute miles per hour;* and was most probably about 7½ miles.

Horse-power of the Ericsson's Engines, developed on the trial trip. Working pressure of air, 8 lbs. + 15 lbs. Supposing the

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* If we take the **number of revolutions of the paddle wheels at 9¼, the speed comes out 7·88 miles.**

cut off to be at $\frac{15}{23}$ (=·652) of the stroke, then the mean effective pressure, in each cylinder, would be 6·4 lbs. + 15 lbs.; and the horse-power of both engines, calculated by the rule given on page 403, would be 311. If we take the cut off $\frac{63}{100}$, as it is stated to be in some accounts, then the mean effective pressure in the working cylinder we find to be 6·04 lbs. + 15 lbs., while that in the supply cylinder remains at 6·4 + 15. With these data the result obtained for the horse-power is 259.

For a mean effective pressure, in each cylinder, equal to 6 lbs. the result is 292; and for 6½ lbs., it is 316.

The power developed by the engines on the trial trip, was undoubtedly less than the determination above obtained (311), for the reasons mentioned on page 403; we may safely conclude that *it could not have exceeded* 300 *horses-power*. It was probably less. This is but one-half of the full power of the engines, according to Captain Ericsson's estimate. This estimate supposes a working pressure of 12 lbs. to be employed, whereas, by reason of leakage, &c., but 8 lbs. could be obtained. In fact, making the calculation on the supposition of a working pressure of 12 lbs., and taking the cut off at $\frac{2}{3}$ stroke, neglecting also the clearance, which is not known, I find the horse-power of the two engines to be 640. The allowance for clearance, and other causes of reduction which have been indicated (see p. 403), may well reduce this determination to 600.

The power, but for practical difficulties, may be indefinitely increased, by enlarging both cylinders, keeping their relative size the same.

It is stated that Captain Ericsson has fixed upon 12 lbs. as the highest limit likely to be practically reached in the working of caloric engines. This must be regarded as an indication either that it is not expected the leakage will be entirely stopped, or that it is supposed that it will not be regarded as safe and economical, to work at the high temperature of 500°, and upwards, necessary to double the expansive force of the air.

Consumption of Fuel, on trial trip, 6 tons of anthracite coal per day, or 560 lbs. per hour. This amounts to 1·87 lbs. per horse-power per hour. If the full power of the engines (600) were to be developed, the expenditure would be 0·93 lbs. per horse-power per hour. On the other hand, if we allow that the excess of pressure in the receiver over that in the working cylinder, on the trial trip, was $\frac{3}{10}$, of a pound per square inch, and the excess of pressure in the supply cylinder over that in the receiver the same, we find that, with a cut off at $\frac{2}{3}$, the horse-power developed could not have been more than 248. The expenditure of fuel, answering to this determination, would be 2·26 lbs. per horse-power per hour.

COMPARISON WITH THE STEAM ENGINE.

1. *Comparative Consumption of Fuel.*

This is presented in the following table.

TABLE I.

Name of ship.	Press. of steam or air.	Horse-power.	Lbs. of bit. coal.	Equiv. lbs. of anth. coal.
	lbs.			lbs.
Ericsson, ...	6·4	300	. .	1·87
"	6·3 and 6·9	248	. .	2·26
"	10·3	600*	. .	0·93
Humboldt, ...	22·1	2397	2·71	2·23 to 2·37
Franklin, ...	20·3	1732	3·55	2·48
Washington, ...	18·3	992	3·38	2·37
Hermann, ...	17·4	944	3·42	2·39
Ohio, ...	23·4	1732	. .	2·59
Georgia, ...	23·4	1732	. .	2·59
Falcon, ...	22·5	534	3·81	2·66
Fulton, (the third,)	31·8	823	. .	2·77
South America, ..	31·8	1168	. .	2·60

The second column shows the mean effective pressure of the steam, or air, per square inch, on the piston; the third the real horse-power actually developed by the engines of each ship; the fourth the number of pounds of bituminous coal, per horse-power per hour, consumed; the fifth the equivalent amount of anthracite of coal, i. e., the number of pounds that would do the same work. These several quantities answer to the average performance of the engines, except in the case of the South America, (a Hudson river boat,) in which they show the maximum performance. The data for the calculations were obtained for the most part, from Stuart's "Naval and Mail Steamers of the United States." The mean effective pressure of the steam, for the whole stroke, has, in each instance been diminished 2 lbs. to allow for the reaction of the imperfectly condensed steam on the other side of the piston. The reductions from the fourth to the fifth column were effected, except in the case of the Humboldt, by multiplying by $\frac{7}{10}$ (nearly in accordance with the results of certain experiments and investigations made by Charles B. Stuart, Esq., Chief Engineer of the U. S. Navy. (See work just quoted, pp. 183 and 186.)

The following results were obtained by diminishing the average boiler pressure 2 lbs., which is about the usual excess of the boiler over the cylinder pressure.

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* This is Capt. Ericsson's estimate of the power of the engines at a pressure of 12 lbs. in the receiver.

TABLE II.

Name of ship.	Effec. press. of steam or air.	Horse-power.	Lbs. of bit. coal.	Equiv. lbs. of anth.
	lbs.		lbs.	lbs.
Ericsson, ...	6·4	300	. .	1·87
"	6·3 to 6·9	248	. .	2·26
"	10·3	600	. .	0·93
Humboldt, ...	20·5	2235	2·91	2·31 to 2·54
Franklin, ...	18·8	1607	3·82	2·67
Washington, ...	16·9	911	3·66	2·56
Hermann, ...	16·0	866	3·72	2·60
Ohio, ...	21·7	1606	. .	2·80
Georgia, ...	21·7	1606	. .	2·80
Falcon, ...	20·8	494	4·12	2·88
Mississippi, ...	14·0	539	5·26	3·68
Arctic, ...	19·0	2290	. .	3·50
Fulton, (the third,)	30·1	776	. .	2·93
South America, ..	30·1	1104	. .	2·75

In the two cases of the Arctic and Mississippi, the mean effective cylinder pressure was obtained by an indicator. The results, given for the other steam ships would doubtless be nearer the exact truth if an additional allowance of from 1 lb. to 2 lbs. were made for the greater reaction of the partially condensed steam in the cylinder than in the condenser. If an allowance of 2 lbs. be made, on this account, we obtain the following result.

TABLE III.

Name of ship.	Effec. press. of steam.	Horse-power.	Llbs. of bit. coal.	Equiv. lbs. of anth.
	lbs.		lbs.	lbs.
Humboldt, ...	18·5	2017	3·22	2·65 to 2·82
Franklin, ...	16·8	1436	4·27	2·99
Washington, ...	15	862	4·15	2·90
Hermann, ...	14	758	4·22	2·97
Ohio, ...	19·7	1458	. .	3·08
Georgia, ...	19·7	1458	. .	3·08
Falcon, ...	18·8	446	4·56	3·18
Mississippi, ...	14·0	539	5·26	3·68
Arctic, ...	19	2290	. .	3·50
Fulton, ...	28·1	727	. .	3·13
South America, ..	28·1	1036	. .	2·94

The average consumption of anthracite coal by the several steam ships named in the table is 3·11 lbs. per horse-power per hour. Dividing by 1·87 and 2·26, we obtain the quotient 1·66 and 1·38. From which it would appear that the advantage is in favor of the caloric engine, in the proportion of 5 to 8·3, for the one estimate of the horse-power developed on the trial trip, and of 5 to 6·9 for the other estimate. If Ericsson's estimate of the power of the engines of the caloric ship should hereafter be realized, then the gain in the expenditure of fuel, would be in the ratio of 1 to 3·39. But we shall soon see, in another connection, that the comparison ought rather to be made with the numbers given in Table II. If this be done, (omitting the results obtained for the Mississippi and the Arctic, which correspond more nearly to the supposition made in Table III), we find the advantage in favor of the Ericsson, in so far as it has hitherto shown its capabilities to be in the proportion of 5 to 7·3, or 5 to 6; that is, to be in all probability, in a ratio lying between these two limits. If we make a comparison with the Washington and the Humboldt, the highest admissible ratio is found to be $\frac{6{\cdot}8}{5}$, and the lowest $\frac{5{\cdot}7}{5}$.

We conclude therefore that the saving of fuel hitherto effected in comparison with the condensing steam engine, in its most economical operation, is not more than $\frac{2}{7}$,* and may be as low as $\frac{1}{6}$.

At the same time it is to be observed that if the supposed inherent capabilities of the new engine should be realized, the saving effected might amount to no less than 70 per cent.

2. *Weight of the Engine.*

Calculation of the Weight of the Engines of the Ericsson.—Weight of hull, from 1200 to 1300 tons, as deduced from the weight of the hull of the Arctic; displacement, at 17 feet draft, 2200 tons, as calculated by the builders of the ship; ballast, 200 tons of pig iron; weight of masts and rigging, coal, &c., 100 tons, at the outside: hence weight of the engines and paddle wheels, $= 2200 - 1300 - 200 - 100 = 600$ tons, or $2200 - 1200 - 200 - 100 = 700$ tons.

I find that the same rule for the calculation of the displacement, from the length, breadth, and depth, which gives the displacement of the Arctic correctly, and a near approximation to that of American steamships generally, makes that of the Ericsson at 17 feet draft, about 2600 tons, which is 400 tons above the estimate made by the builders of the ship; a fact which is to be attributed, doubtless, to the peculiar model of the ship.

Comparison with weight of Steam Engine.

	Horse-power.	Weight.	Rates of weight to horse-power.
Mississippi, ...	539 (developed)†	494 tons.	0·91
Missouri, ...	600 (estimated)	500	0·80
Saranac, ...	605 "	367	0·61
Michigan, ...	334 "	160	0·48
Niagara, ...	1440 (developed)	150	0·10
Ericsson,‡	300 "	600	2·20
"	300 "	700	2·33
"	600 (estimated)	600	1·00
"	600 "	700	1·16

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* If the comparison be made with the Ohio and Georgia, the saving may be nearly [illegible].

† This shows the horse-power of the Mississippi developed in its average performance. There can be no doubt that its full power is over 600; and therefore that the ratio of the weight to the horse-power is as low as 0·82. Besides, the weight of "wheels, bunkers, tools, duplicate pieces of engine, stores of the engine department, &c.," is set down at 288 tons, which is more than 100 tons above what would be deemed a sufficient allowance. Reducing the total weight to 400 tons, we have the ratio 0·67.

‡ If we take the lowest determination of the horse-power of the Ericsson, viz., 248, the ratio of the weight to the horse-power comes out 2·82.

The numbers given in the second column include the weight of the boilers, water in boilers, coal bunkers, and all appurtenances, together with the weight of the paddle wheels.

It appears from this comparison that, in proportion to the actual horse-power, the weight of the Ericsson's engines is about three times as great as the ordinary weight of the engines of sea steamers; and in proportion to the estimated power, more than 30 per cent. greater.

3. *Space occupied by the Engines.*

This point has been attentively considered by a correspondent of the Journal of the Franklin Institute (see the second February number of the Journal, p. 128), who shows that here also the advantage is on the side of the steam engine;—the economy of space being nearly twice as great.

4. *Friction and other Resistances.*

We may obtain an estimate of the comparative resistance, in the two forms of engine, to be overcome by the moving power, by reducing the power of several steam engines to the speed and immersed midship section of the Ericsson on the occasion of the trial trip; that is, calculate what reduced power they would have if they were just capable of propelling with a speed of 7 or 7½ miles per hour, the ships in which they are placed, if the area of the immersed midship section were the same as that of the Ericsson at 17 feet draft, i. e. 520 square feet. This may be effected by observing that the horse-power will vary nearly as the cube of the velocity multiplied into the area of the transverse midship section. This is quite near the truth, if we suppose the diminution of power to be accomplished by reducing the area of the piston, and other parts of the engine proportionally; the pressure of the steam, cut off, and all other circumstances remaining the same. The following table contains the results of a few calculations made by the rule just stated.

	Horse-power.	Speed.	Area of mid. sec.	REDUCED HORSE-POWER.	
				Speed of 7 miles.	Speed of 7½ miles.
		miles.	sq. ft.		
Mississippi,	539	8·4	684	224	276
Arctic,	2290	13·4	685	215	264
Washington,	911	11·0	608	202	247
Fulton,	776	13·3	281	210	259
S. America,	1104	18 (assumed.)	132	257	316

These determinations, although they differ considerably among themselves, as was to be expected, from the variety of size and model of the hulls of the several vessels selected, as well as of construction and operation of the different engines, and are not to be regarded as very exact, still serve to show that no just claim can be set up of superiority on the part of the hot air engine over the steam engine, on the ground that the resistance incident to the movement of the engine is decidedly less. Also, on observing that the horses-power given in Table II. were used in making the calculations for the Washington, Fulton and S. America, it will be seen that the statement just made is still true if we include among the several resistances in play in the steam engine, the excess of the reaction of the partially condensed steam in the cylinder over that of the same in the condenser. We may hence conclude that we were justified in making the statement that the comparative consumption of fuel by the two engines, in producing the same useful effect, is to be ascertained by taking the determinations of expenditure given in the last column of Table II, rather than the larger values to be found in Table III.

5. *Adaptation to the production of high velocities.*

At double the speed of the Ericsson on the trial trip, that is at 14 to 15 miles per hour, the horse-power would be about eight times greater, or about 2400; and the quantity of coal consumed, deduced from the present capabilities of the engine, would be eight times greater, or 48 tons per day. This supposes the draft to remain the same, whereas it will be materially increased by the necessary augmentation of the weight of the engines. In fact the weight of the engines at the speed supposed would be about three times as great as their present weight. At her present draft, (viz., 17 feet,) an additional weight of 200 tons would sink the hull of the Ericsson one foot. Taking the lowest estimate of the weight of the present engines (600 tons), the necessary addition of weight would not be less than 1200 tons; which would sink the hull nearly 6 feet, or increase the draft to about 23 feet, that is, make the draft after the 200 tons ballast is removed, 22 feet; which is from 1 to 2 feet deeper than the load-line. The midship section would thereby be enlarged to 720 square feet, and therefore the power necessary for the production of the double velocity augmented in the proportion of 520 to 720. If this be done, we find the required horse-power to be 3320. The corresponding consumption of coal would be 66 tons per day. Now even at 50 tons per day the stock of coal required for a transatlantic voyage of 12 days duration, would not be less than 600 tons; which would produce an additional depression of the hull, of nearly 3 feet, or sink it some 5 feet deeper than the load-line. If it should be maintained that the weight of the engines would not be more than doubled, the depression produced by the engines and the necessary supply of coal would still be below the load-line. Again, if it should be conjectured that the consumption of coal will not be augmented, in the case of the caloric engine, in the same proportion as the real horse-power, to show that this supposition is erroneous it is only necessary to state that, as a matter of fact, the amount of coal consumed for each horse-power by the engines of the Ericsson, is even greater than that consumed by the stationary caloric engine. Ericsson gives 60 as the horse-power of the stationary engine, and 0·6 lbs. per horse-power per hour as its consumption of fuel, and 600 and 0·9 lbs. as the corresponding quantities in the case of the Ericsson's engines.

Let us now see what will be the result in case the estimated capabilities of the caloric engine should be realized. If the horse-power should be increased from 300 to 600, the speed of the ship would be increased nearly in the proportion of the $\sqrt[3]{300}$ to the $\sqrt[3]{600}$, or of 6·69 to 8·43; that is, to 8·82 or 9·45 miles per hour, according as the speed on the trial trip is taken at 7 or at 7½ miles. To obtain a speed of 15·5 miles, which is the speed of the Arctic in still water, the expenditure of fuel must be increased in the proportion of $(8·82)^3$ to $(15·5)^3$, or from 6 to 33 tons, disregarding the increase of draft. As a matter of fact the weight of the engines will be augmented in about a two-fold proportion, which will increase the draft nearly 3 feet; or make the draft, after the ballast is removed, about 19 feet, and thereby augment the necessary consumption of fuel to 38 tons. The supply of coal for a 12 days voyage at 50 tons per day would be 600 tons; this additional load would increase the draft on leaving port to 22 feet, which is some 2 feet deeper than the load-line.

If we take the other estimate of the velocity answering to 600 horses-power, viz., 9·45 miles, the amount of coal required, at the velocity of 15·5 feet in still water, will be about 30 tons per day, or 450 tons for a voyage of 15 days. The addition to weight of engines will not be less than 360 tons; and $360+450=810$ tons will just sink the ship to the load-line.

The Arctic would accomplish the voyage in the same time, and carry not less than 700 tons freight. But in doing this her engines would consume about 600 tons more coal than those of the Ericsson in the case supposed. This estimate of the highest possible performance of the Ericsson is so near an approximation to the performance of the steamships of the Collins' line that it must be admitted to be within the bounds of possibility that caloric ships may hereafter compete successfully with these celebrated steam-ships. At least this conclusion seems to follow, unless we have underrated the necessary weight of the caloric engines. It must be left to time to decide the question, whether the full estimated power of the caloric engines can be actually obtained; and whether, therefore, the results which have been indicated, will, from being a mere ideal limit, ever come to be an actual realization.

With her present capabilities the average speed of the Ericsson at sea would not exceed 6 miles per hour (see Journal of the Franklin Institute for February, No. 2, p. 127); and she would require 24 days to perform the voyage to Liverpool (3550 statute miles). It seems highly probable that her speed will be increased by alterations and improvements in her machinery, but it is to be observed that when depressed to her load-line, the full estimated power of her engines will propel her at no more rapid rate than 8½ miles per hour, in still water, and less than 7 miles per hour at sea.

6. *Application to Inland Navigation, &c.*

The weight of the caloric engine, and the large amount of space which it requires, would seem to preclude all hope of applying it successfully, in its present form, to river or lake navigation or to railroad locomotion. (See table on p. 408.) In its application to manufacturing purposes and to the drains of mines, &c., the same objections will have much less force, and a favorable result may therefore be more confidently expected. In this point of view, however, a comparison should be instituted between the caloric engine, and the high pressure steam engine working very expansively.

General Conclusions.

The more important general conclusions to which this comparison has conducted are,

1. That Ericsson's Hot Air engine, as compared with the condensing marine steam engine in its most economical operation, has shown the ability to do the same work with the use of from $\frac{1}{6}$ to $\frac{1}{3}$ less fuel; and that if its full estimated power should hereafter be developed, the saving effected would be 70 per cent.

2. That, for the same actual power its weight is about three times as great as that of the marine steam engine, and that in case its estimated power should be obtained, its weight would be as much as 30 per cent. greater.

3. That, in respect to the space occupied by the engines and coal, the advantage is decidedly in favor of the steam engine.

4. That, the great weight of the engine in proportion to the power developed, must prevent, for the present, the realization of a high speed in the propulsion of vessels. At the same time it is to be admitted that the full estimated power is adequate to the production of high velocities. Time alone can decide the question whether or not this maximum power is really obtainable.

5. The great weight of the engine, and the space occupied by it in its present form, will in all probability prevent its adoption for the purposes of inland navigation and railroad locomotion, in preference to the steam engine. If used as a land engine,

these features will be less objectionable; accordingly it is only in this form of application, and in those cases of marine navigation in which speed is likely to be sacrificed to economy of fuel, that the caloric engine may be confidently expected to achieve a decided triumph over the condensing steam engine.

Although this discussion has brought us to the conclusion that the new motor is not likely to equal the extravagant expectations which are so widely entertained with regard to its capabilities, still it must be freely conceded that the invention of a new engine in respect to which a just claim to superiority over the steam engine can be asserted, in any particular, is a great achievement, and that the ingenuity and mechanical skill displayed in the invention and construction of the Caloric Engine cannot be too highly extolled.

SCIENTIFIC INTELLIGENCE.

I. Correspondence.

Correspondence of M. J. Nicklès, dated Paris, January 9, 1853.

On the Verification of a Standard Meter.—In my last review, I pointed out the general process followed by M. Silbermann in verifying the meter sent to the United States by the French Republic. It remains to complete the description, which I can readily do with the accompanying drawings received by me from M. Silbermann.

Figure 1 represents the rule of steel (a, a') plunged in a bath of melting ice, by which it is thus kept at an unvarying length; b, b', are the dry points, for marking the length upon the bar under experiment; they are of tempered steel, and very firm; the extremities are turned with care and converge to a point at an angle of about 60°. The distance between the points is 1-200ths of a millimeter less than the length of the meter in the melting ice.

It will be remembered that this compass is applied twice to the rule under trial, first when this rule has been put in melting ice, and afterwards when it has been kept for two hours in boiling water. We obtain thus four marks, to which the form of arcs of a circle are given.

The distance between these arcs is determined by means of the apparatus, fig. 2, contrived by M. Silbermann for comparing the meter sent to the United States with the Governmental Standard. The following are explanations of this apparatus, which may obviously be applied to the study of dilatations in general.

The base of this "Comparator" consists of two rules $a\ a'$, $b\ b'$, of the same breadth and nearly of the same length; they are placed one over the other and firmly pinned together at c', (to the right in fig. 2.) The lower rule, $b\ b'$, is of bronze, the upper $a\ a'$, (upon which the meter under trial is placed,) of platinum. Each is 30 millimeters in breadth. Their other dimensions are as follows:

	Length.	Thickness.
Platinum rule,	$1^{\mathrm{mm}}\cdot 12$	$3^{\mathrm{mm}}\cdot 50$
Bronze "	$1\ \cdot 13$	$7\ \cdot 00$

The length of the meter is obtained between the heel-points, d, d', (or the extremities of the shorter arms df, $d'f'$,) of two levers, de, $d'e'$, one lever at either extremity of the measure; the longer arms of which levers serve to multiply any minute differences of length in meters placed between the heel-points. The axes, ff', upon which the levers move, are firmly fixed to the lower rule. The short arms, df, $d'f'$, are 8 millimeters long, and are curved. The long arms, fe, $f'e'$, are 160 mm. long. These levers are placed vertically, above the rule to which they are joined by the piece supporting the axis of motion. This axis moves between the points of two screws, secured in the support.

The lever $d'e'$, (situated on the side a', to the right in figure 2 where the two rules are united together,) serves as a striker against one end of the meter under trial, the axis of rotation (f') of this lever being firmly attached to the rule.

The other lever, de, (contact-lever) is brought into contact with the extremity of the introduced meter; and to accomplish this, it is moved by the slide ghi, through the action of a micrometric screw (s), the nut k, of which is fixed to the rule of bronze by means of a projection which unites the two pieces. The amount of movement required of the plate ghi, is measured by the micrometer screw, which is therefore the measuring apparatus, properly so called.

In order not to injure the extremities of the introduced meter, the two levers are held against these extremities only by means of a small spring, l, l', the power of which does not exceed five grammes. The curved extremity d, d', of the small arms, is cylindrical and horizontal, and presents for contact with the introduced meter, an edge 2 millimeters in length.

At the summit m, m', of the piece constituting the support of each lever, there is a zero mark, and also another on the top of the lever; the coincidence of these two gives the requisite length for the interval between the extremities of the short arm of the levers. To increase the precision, five marks are made instead of one, two either side of the zero mark, and the intervals on the top of the lever are slightly less than those on the support, in order that they may act as a vernier; and to give still greater exactness to the observation, there is an eye glass to each support. If the small arms of the levers d, d', are 1-1000th of a millimeter out of the way, it is indicated at the extremity of the long arm by half a division on the vernier, a quantity quite appreciable by means of the lenses.

To make the delicate contact required, for which pushing with the hand alone would be unsatisfactory, there is a piece p, (right end, in fig. 2) which presses against the measure by its side. This piece terminates in a horizontal tail piece q, which connects with a thumb screw, r, not very fine in its thread, that passess through the foot of the support. This screw is situated in the prolongation of the upper surface of the platinum rule, upon which surface the rule under trial rests.

The micrometric screw, s, above alluded to, makes just a semi-millimeter each revolution. The head t, is divided into 500 parts, and subdivided into 5000 by a vernier, (v) fixed to the support. The millimeter is thus graduated to 10,000 parts, which is equivalent to 10-mil-

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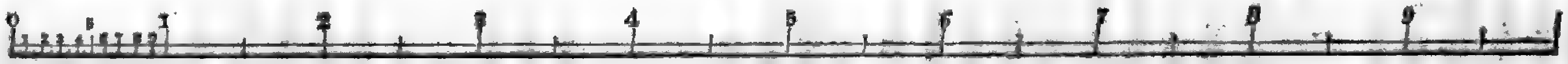

lionths of a meter, or the relation between a meter and a quarter of a terrestrial meridian. This screw turns between two points *x*, screwed into the slide which supports the contact lever, and is situated in the same line with the points of contact.

The delicacy of the points of contact being ascertained, there is still a condition to be provided for, viz.: the invariability of the distance between the two heel-points of the levers, an invariability constantly disturbed by variations of temperature.

To insure an invariable length in the bronze rule, which serves as a support to the levers, M. Silbermann applies to this rule, the rule *a a'* of platinum, which, as the dilatation of the two metals is very different, makes of the couple a thermometer of Borda (fig. 2); and it indicates for each instant, the temperature of the system. This is the object of uniting the two rules at one end *c*, by a pin which goes through both, while at the other end, they are free. The difference of dilatation is indicated by a scale *c*, divided into fourths of millimeters, traced upon the platinum rule. A vernier made of a plate of platinum is fixed against the bronze rule, which divides 24 of these fourths into 25 parts, and indicates thus hundredths of a millimeter. This plate serves also to guide the platinum rule, while the foot of the nut of the micrometric screw guides the rule on the other side.

For multiplying the movements of dilatation of this thermometer of Borda, the lever $d'' f'' e''$, (fig. 2) is introduced. The arc e'' which terminates the arm of the lever, $f'' e''$, carriers a vernier which moves against a divided arc, m'', whose foot carries the axis f'', of the lever fixed to the bronze rule *b b'*. The divisions of the vernier register 50ths of a degree of temperature.

This apparatus for the comparisons ("comparateur") rests on several pieces, *y*, of equal thickness, and these on a support of brass, accurately planed.

The following is briefly the method of using this apparatus in comparing a meter under trial with the prototype standard.

The standard is put upon the Borda thermometer (fig. 2); the whole is placed in ice; by means of *r*, its extremity is put into coincidence with *d'*, so that the two zero marks *e' m'*, are coincident; then by means of the screw *t*, the slide *g h i*, is moved until the extremity *d* of the small arm of the lever touches this extremity of the standard meter, so as to bring into coincidence the two zero marks.

This same operation is performed with the meter under trial and the difference is noted on *v*. This reading is quite correct, only when the Borda thermometer indicates that the temperature has not varied.

Standard Meter.—The standard meter is made of annealed steel, placed on a rule of bronze which forms with it a Borda thermometer. The free extremities of these two rules carry each a divided scale. The scale of the bronze rule is cut on a silver plate, *f;* its divisions are fourths of a millimeter. The vernier is fixed upon the steel rule: it consists of a plate of silver imbedded in the surface of the rule and registers hundredths of a millimeter.

This standard meter may be used for comparison with meters which measure a meter either between the extremities, or between marks on the surface. In the former case, the meter is inserted between the heel-pieces, d, d', and in the other the graduated part of the meter is placed under the two microscopes, o, o'.

The divisions $f\,f'\,g$, &c., on this meter serve to correct for temperature and to reduce it to the standard temperature, which is that of melting ice.

The above descriptions will suffice, I think, for repeating the comparisons, and also for generalizing the results, while we wait for the publication of M. Silbermann's memoir. The employment of Borda's thermometer, which is a novelty in this department, is of great importance, as it registers the slightest change of temperature.

On comparing Standard Weights in a Vacuum.—Before leaving this subject of weights and measures, I add a few words on M. Silbermann's process for comparing standard weights in the vacuum of an air-pump, a process deemed impracticable, until accomplished by M. Silbermann, and whose success shows that in the physical sciences there is nothing we need despair of.

The weight under trial is a brass kilogramme. Two bell-glasses (fig. 4) are taken, large enough to contain the weight, equal in volume (0·20 litre) and in weight, and furnished above with a small stop-cock. Each bell-glass is placed on a disk of ground glass, used as a moveable plate.

The disk and bell-glass are united by the method of M. Poinset, superintendant of the Laboratory of M. Payen, at the Conservatory of Arts and Measures; that is, by covering the edge of the bell-glass with a thin band of vulcanized caoutchouc from which the excess of sulphur has been removed by means of a potash lye. The band thus arranged, intervenes between the bell-glass and the plate, and if sufficiently thin, the vacuum is maintained in perfection.

After placing the standard kilogram in one of the bell-glasses, the kilogram under trial is placed in the other. The vacuum is then made in both together by means of an air-pump; hydrogen is introduced before it is complete; after expelling which, by continued pumping, the pressure is so far reduced as ordinarily not to exceed two millimeters, so that the weight of hydrogen left, representing this pressure, is not appreciable to the balance.

The weight to be considered is moreover the difference of the weights of the displaced volumes, a weight inferior to that of the hydrogen, which is itself under this pressure only

$$\frac{0{\cdot}20\,\text{lit.} \times 0{\cdot}0898\,\text{gram.} \times 3\text{mm.}}{760\text{ mm.}} = 0{\cdot}00047\text{ gr.}$$

or hardly 5-hundredths of a milligramme.

After putting the two exhausted bell-glasses, each on one of the scales of a balance and establishing an equilibrium by means of small weights, the bell-glass containing the standard kilogram is removed and replaced by the kilogram under trial. The vacuum is made as before, and reduced precisely to the same degree of pressure, after which the bell-glass is placed on the scale of the balance and poised with a small weight, which weight enters into the calculation.

Correspondence of M. Nicklès dated Paris, March 8, 1853.

Caloric Engine.—The use of hot air as a motive power in place of steam has been the general topic of conversation among men of intelligence, since the attention directed to the subject by accounts in the American papers of the experiments of Captain Ericsson. Reclamations flow into the Academy of Sciences, not for priority as to the idea of employing hot air for producing motion, an old principle, and of unknown origin,[*] but for the use of a metallic net-work for saving or storing the heat. This idea appears to have occurred independently to Captain Ericsson, MM. Franchot, Lemoine, and Lobereau, who, unknown to one another, have applied it in the construction of machines; it is evidence of their good faith in the question that they have each patented their inventions, which they would not have ventured to have done, if they had been aware of previous inventions of the kind.

M. Burdin, mining engineer, brought out a machine of another kind, using in place of a metallic network, a column of sand, which without doubt is less effectual. He was occupied in the construction of a machine of 8 to 10 horse-power, on this basis, when the revolution in February changed the nature of his labors.

The priority, so much disputed, appears at present to belong to M. Franchot,[†] as well as to Captain Ericsson, for the latter does not date his title anterior to 1838, which is the same period with the patent of M. Franchot.[‡]

A machine of this kind constructed by M. Franchot was submitted in 1840 to a commission named by the Academy of Sciences, composed of MM. Poncelet, Séguier, Coriolis, Savary, and Pouillet, and it was put in operation before these judges. M. Pouillet, who was charged with reporting on the engine, used his efforts towards burying the memoir of M. Franchot in the "cartons" of the Academy, with his usual aversion to innovations in general; an aversion which he exhibited before the full Chamber of Deputies, with reference to the Electric Telegraph, speaking of it as Utopian and chimerical, at a time when this admirable invention was already in successful action in the United States.

We do not describe here this machine, as it has only an historical interest, for it does not equal in any respect that of Capt. Ericsson. It has been claimed for Ericsson's machine that it realizes an economy of 95 per cent., and in consequence of this exaggeration, some persons have fallen into the opposite extreme, and have strongly argued before the Academy of Sciences, and the Société d'Encouragement, that the saving is actually nothing, and that the regenerator instead of being an

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[*] In 1806 the Brothers Niepce, afterwards inventors of the daguerreotype, presented to the Academy of Sciences an apparatus which they called a *pyreolophorus*, in which air strongly heated produced the effect of steam. It was the subject of a commendatory report by Berthollet and Carnot.—N.

[†] M. Franchot was the originator of the electro-magnetic pendulum, and also inventor of the lamps called "moderator," which have brought in a short time some millions of francs to the successful speculator, who has appropriated to himself the patent of the inventor.—N

[‡] We learn that Ericsson's patent dates as far back as 1833.—Eds.

aid, is a hindrance in the machine, such persons alleging that the greater part of the heat is lost in the state of latent heat, and that there is a set-off for the rest in the resistance which the metallic network offers to the passage outward of the hot air.

MM. Galy-Cazalat and Liais, who have come out as the opponents of Ericsson's invention, do not appear to understand the true use of the regenerator, to which they attribute a uniform temperature after the column of hot air has deposited there its caloric, and deny wholly its value. They might as well deny the possibility of bringing into use the currents of air which escape from a furnace. Besides, these writers calculate that the 155 square meters of wire network in the regenerator must weigh 15,000 kilograms, amounting to 90 kilograms the square meter. But little experience is needed to show that this is not so; a square meter of the wire network of 65 wires to the inch weighs barely one kilogramme. There is more than one mistake in the memoir of M. Galy-Cazalat; and M. Liais errs in like manner. It is to be noted that both of these mechanicians have constructed hot air engines which they claim will operate economically without a regenerator. M. Galy-Cazalat concludes by advising Captain Ericsson to do away with the regenerator, and give, per horse-power, 40 square decimeters to the surface heated. "This surface in the caloric engine," says he, "is so small and so highly heated that it allows two-thirds of the heat to escape uselessly into the atmosphere; so that the economy due to the regenerator, were it real, should be reckoned only with reference to the one-third of the combustible usefully employed." One passage in his memoir meets with general and hearty approbation. "As regards the interests of mechanics, all mechanicians are vastly indebted to Mr. Ericsson and the capitalists who have seconded his efforts. Whatever the result, to Captain Ericsson belongs the honor of having made the first great successful attempt in substituting hot air for steam, in a vessel of the first class."

Engine, using the vapor of water at a high temperature.—The magnificent experiment in the bay of New York has excited special attention in France to the subject of motors in general. Some important facts have come to light within a few weeks, which deserve mention.

The use of the vapor of water at a high temperature has been the subject of extended researches, and its application in the production of motion has been attempted both for stationary and locomotive engines. Whilst I was experimenting on the Lyons railroad upon the magnetic adherence of the wheels and rails,* there was a trial being made at the same time with a locomotive moved by super-calorized steam, the plan of which is still kept secret; and it was afterwards abandoned for the same reason that had led Seguier to lay aside his enterprise of a similar kind, who, on constructing a steamboat to be thus moved, was frustrated by the rapid destruction of the tubes of copper which supplied the steam. M. Belleville of Nancy has taken up this subject, according to MM. Seguier and Jobard, and has met with complete success; the machine constructed by him worked for five weeks at Labriche, near Paris, having been substituted for a steam engine of 29 horse-power, with a saving of 40 per cent.

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* See this Journal, this volume, p. 106.

Chemists will be surprised to learn that M. Belleville owes his success to the use of iron for the pipes alluded to. The drawing of this metal into pipes of a certain length—a recent invention by M. Gandillot—has come to the assistance of M. Belleville; and the iron is so perfectly soldered as to resist the strongest pressure.

"To create vapor in like manner as it is destroyed in the worm of a still," says M. Seguier, "was one of the most important problems to be resolved in the present state of science." There is also one other, which is, that of employing vapor directly, without an intervening medium.

Much labor has been spent upon the study of reaction, and the known principle that reaction equals action. But that which is incontestable as a principle, has not yet been established by practice. The invention of M. Belleville will contribute greatly to this end, owing to the facility and the safety with which he is enabled to produce vapors at pressures exceedingly elevated. It appears that M. Jobard only awaits the result, in order to carry out an idea of this kind which he has had under contemplation for several years.

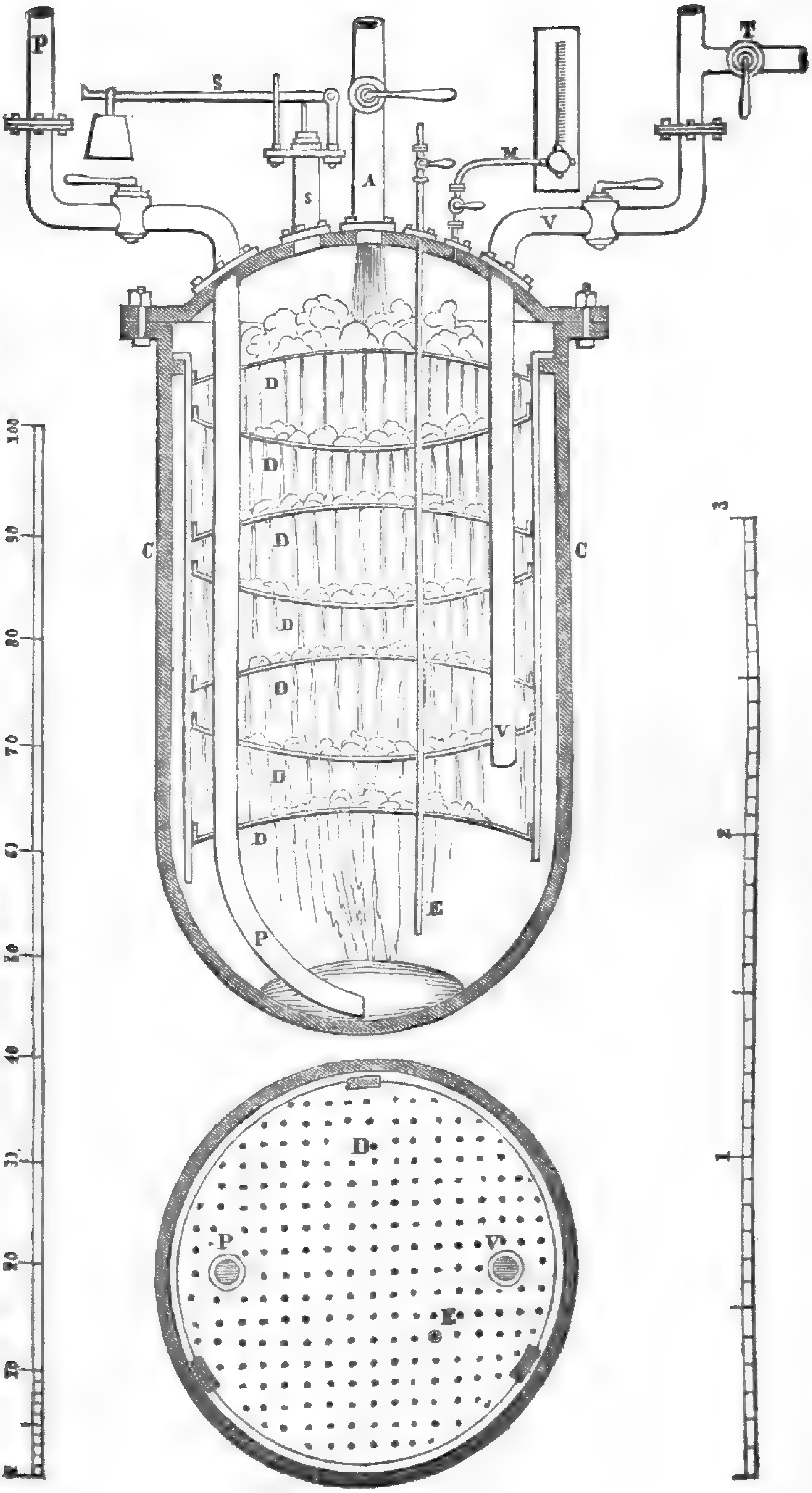
It is evident that by the direct use of steam and the worm of M. Belleville, the steam engine will not occupy one-tenth the space, nor have a tenth part of the weight, nor cost as much by one-tenth, as the ordinary engine.

It appears that the human mind cannot arrive at simplicity except by passing through the complex; it is like a mountain more or less elevated, whose heights must be overcome before the plain at the opposite base can be reached: and when reached, the level seems to be that of the plain left behind. So when a simple solution of a problem is arrived at, we think it an easy natural thought and almost self-evident.

Engine of M. Beauregard.—These views have for a long time been defended by M. Moigno, with especial reference to a machine for supercalorized vapor by M. T. de Beauregard, based on the principle of the *spheroidal state*, discovered by M. Boutigny, and which has led to the invention of an engine of small power which is constantly at work in the manufactory of sperm candles of MM. Jaillon, Moinier & Co., at La Villette near Paris.

The peculiarity of the engine consists in the boiler (fig. 1) which is a cylinder, hemispherically cup-shaped below, having above a cover bolted down, and furnished with all the ordinary apparatus of a steam engine: a supply tube, A; steam pipe for the steam, V; blowing off pipe, P; a steam guage M; safety valve, S; escape pipe for excess of steam, placed at T on the tube which supplies the steam or vapor to the engine. The cylinder contains within 5 to 7 diaphragms, the borders of which are bent upwards, they are alternately convex and concave and pierced with small holes from below upward. By this arrangement, the water passes over a large surface to arrive at the bottom of the cylinder where it enters the spheroidal state. It falls like rain from the first diaphragm to the scond, from the second to the third and so on. Besides, on the first diaphragm, which is convex, the water goes from the center to the circumference; on the second, from the circumference to the center, &c., so that it passes over the largest possible surface, which is farther augmented in extent by the small holes. The diaphragms are kept at the right distance apart by rods of iron.

1.



2.

The steam is taken from between the last diaphragm and the preceding, counting from the top. This arrangement tends to establish an equilibrium of temperature between all parts of the cylinder, and to give uniformly to the steam the tension desired. The usual pressure in the boiler is 5 to 10 atmospheres.

In bringing the generator into action, it is heated dry for some minutes; then by means of a hand pump, a few glasses of water are thrown into the boiler, the steam-guage being put in connection, and 25 minutes afterward, the engine is brought into action which feeds thence the boiler.

In an experiment continued for 9 hours, 351 kilograms of water were evaporated, whose initial temperature was 39° C. The coal consumed was 81 kilograms; pressure produced, 10 atmospheres. This pressure supposes a temperature of about 181° C., and since, according to Baudrimont, iron possesses its greatest tenacity at near 200° C., this temperature tends to increase the resistance of the sides of the boiler, instead of proving unfavorable to it.

M. Boutigny, who has detected through his researches on the spheroidal state, one of the causes of the explosions of steam engines, has studied with care the chances of accident to which the boiler of his invention is exposed. He recognizes the following.

1. The decomposition of water, by the red-hot metal.

2. Excess or deficiency in the supply for the boiler. As to the first, if it takes place, there is actually no increase in the volume of the vapor; 6 volumes of steam ($3H^2O$), *plus* 2 of iron (Fe^2), give $6H+Fe^2O^3$.

As to the second, it is apparent that the vapor will decrease rapidly as the supply is suspended, and the danger will thus be averted. But it may be feared that the bottom of the boiler being no longer supplied with water will redden strongly; and that when water is admitted, this water, spheroidalized at first, will abruptly lose its spheroidal condition from the lowering of the temperature by the continued accession of water, and so by sudden evaporation, produce an explosion—a result that happens under certain conditions in ordinary steam boilers. The fear of such a catastrophe is dissipated on inspecting figure 1, where it is seen that the water falls and evaporates in the diaphragms which are not exposed to a red heat; in consequence of this evaporation, the equilibrium of temperature will be promptly reëstablished and all danger disappear. M. Boutigny has assured me that he has several times exposed the engine to the worst conditions, without producing either of the accidents mentioned.

Engine of M. Andrand, called Electro-caloric.—In 1844, after several preparatory trials, M. Andrand put in action on the railroad from Paris to Versailles an air-locomotive, in the presence of a commission named by government. Although with some points of resemblance, it was not precisely a caloric engine like that of Ericsson, against whom M. Andrand enters no claim of priority. The locomotive acted through air at first compressed in a heater and then dilated by the heat. The air acted at high pressure and the generator consisted of a worm plunged in a fire for the purpose; on passing through this spiral tube, the air was dilated, then on reaching the motor cylinders it underwent additional dilatation, for the concave bottom of the cylinders were furnished with plates of cast iron, which were at a white heat.

The dilatation thus obtained, increased three-fold, according to M. Andrand, the power of the condensed air; whence he concluded that in order to arrive at a practical solution of the problem, the previous compression could be dispensed with, and obtain at the same time the condensation of the air by using for this purpose part of the expansive force of the caloric.

M. Andrand has not put this idea into practice. But in the course of his trials he has several times remarked an unexpected fact which we here mention.

Before making his air-locomotive public, M. Andrand had had it in operation within his workshop. When the reservoir was well filled with condensed air, the fire of the dilatator was made and the iron plates of the bottom of the cylinders were brought to a white heat. This done, it was only necessary to open the stop-cock of the reservoir to set the machine in motion, and cause the two driving wheels to revolve. But while the apparatus was heating up, and before the valve was opened, it happened several times that the machine started spontaneously and communicated to the two wheels a frightful velocity. The phenomena continued from 30 to 40 seconds, then ceased, without his discovering how it was produced or why it stopped. M. Andrand has not succeeded in repeating it at will. Already, some three years before, the same motion, spontaneous and violent, manifested itself two or three times in a small hot-air car which this mechanician had made to move on rails.

What may be the cause of this singular phenomenon? Those who explain everything by a word, who know the precise cause of the cholera, steamboat explosions, the potato-disease, &c., do not fail to reply that the cause is "electricity," and without looking much to the why or the wherefore, they can easily solve many other difficult problems in the same way. M. Andrand, who has, as a mechanician, a well-merited reputation, must have had recourse to the wisdom of one of these Œdipi, for he does not hesitate to make the cause "electricity."

We add, however, that M. Andrand's explanation is not without a shadow of foundation. The two motor cylinders which act independently on the driving wheels, are of different kinds, one wholly of bronze, the other, by chance, partly of cast iron and partly of bronze. But the phenomenon does not appear to be produced in this last cylinder, and never in the cylinder of one metal.

The two cylinders of the locomotive, in which the spontaneous movement was reproduced, also consisted of two metals, the cylinders being of cast iron, and the pistons and bottom of bronze. From this to the phenomena of Galvani, is but a single step; and M. Andrand is convinced that he has been witness of the mechanical work of the electricity excited by the heat.

Setting aside an explanation which elucidates nothing, and which may mischievously make one believe that the problem is resolved when it is hardly presented, we may conclude with M. Andrand, who says: It will be a conquest, both scientific and industrial, of the first order, when we shall succeed in producing at will, this new motive force, and give it a continued action; then two ordinary motor cylinders, moderately heated and fed successively with a very small quantity of air dry or moist perhaps, will suffice to generate an enormous force, which M. Andrand estimates at 10 or 12 atmospheres, and this with an expense of heat which is altogether insignificant. We shall have then, says he, *electro-caloric* engines which shall leave far behind steam engines, however perfect, and shall realize under volumes of small extent, the marvels attributed to the apparatus of M. Ericsson.

Finally M. Andrand closes his voluminous memoir by the following considerations. "Steam boilers are found, as regards electricity, in conditions analogous to those of our hot-air chambers; it is probable even, that with equal volumes, they contain a much larger quantity. Is it not natural that the phenomena which I have observed, as a matter of chance, in our hot-air cylinders, should be sometimes reproduced in steam boilers?

"It is known that explosions are more violent, the greater the amount of electricity; and on the other hand, that the quantity of electricity is greatest when the steam is of moderate tension, as in steamboats of low pressure engines. And these low pressure engines are the ones which often explode, while the locomotives which are high pressure, very seldom explode." In support of these considerations, M. Andrand says that he has more than twenty times tried to burst vessels of thin sheet iron by compressing in it air at a high temperature, and has not been able to succeed except in tearing them when the pressure was raised to 50 or 60 atmospheres; twice only has he produced an explosion; and these with vessels of copper when other metals were present.

Fusion and volatilization of Platinum and Silica.—BERZELIUS in his Traité de Chemie (German edition) reports that he had seen a mass of semifused platinum which M. Sefström had obtained by heating in an ordinary furnace filings of platinum mixed with charcoal placed in a crucible. This fact, which had been overlooked, has been carefully studied and submitted to examination on a large scale by M. Deville, so that now the fusion of platinum in a coal fire is no more a difficulty, neither the volatilization of this metal.

In order to verify a fact in analytical chemistry concerning the silicates, M. Henri St. Claire Deville put a platinum crucible closed with its cover, in a Hessian crucible, and placed it in a small laboratory furnace. The combustible consisted accidentally of furnace cinders ("escarbilles") and the whole was subjected to the action of the bellows of a forge. On returning after some time to examine the state of the silicate he saw with surprise that the platinum crucible, as well as the Hessian, was reduced to a paste, perfectly fused.

On reporting the facts to the Academy, M. Deville presented a platinum crucible, which he had caused to melt in lime; he had also a cover of platinum upon which there were numerous globules of volatilized platinum, and also a specimen of pure silver fused in graphite.

As sandstone is perfectly fusible at these temperatures, M. Deville substitutes for it some compact lime containing a little silica, which he had carved into a crucible; the air reached the furnace through a plate of iron pierced with holes arranged circularly to a distance of 5 centimeters around the center.

I have seen the apparatus, and observed the simple and easy method of using it; the humble appearance of this small furnace stands out the more remarkably in the magnificent laboratory of the Ecole Normale, where M. Deville carries on his labors. This chemist has also succeeded in volatilizing silica, which had already been previously done by M. Gaudin, with a gas blowpipe of his invention, fed by oxygen.

It is essential for success that the combustible should be of the proper kind, and finely divided. The best is made of the residue of the combustion of coal, mixed with cinders such as escape from the grate of a furnace, and are called "escarbilles." Coke and charcoal have produced nothing satisfactory.

M. Deville informs me that he has found no difference between the fused and welded platinum. We add, however, that he has not compared the electro-chemical properties of these metals, nor the action on light.

Pisciculture.—In the science of practical life in Paris, there is a curious subject of the highest value in Physiology, which may be here mentioned. I allude to Icthyogeny or Pisciculture—an important branch of industry which has been created by M. Remy, an humble fisherman among the mountains of the Vosges. Deferring to another time further remarks, I will here state that I have recently seen in the apartment of M. Millet, an arrangement for the breeding of salmon and trout; and in the space of two months, the apparatus of M. Millet, placed upon the marble of a fireplace, has brought out 19,000 young salmons, and more than 10,000 young trout.

Prize.—The Aerostatic and Meteorological Society of Paris offers a prize for the best material for enclosing hydrogen. The prize is a medal of gold, of the value of 300 francs.

II. Chemistry and Physics.

1. *Compass of Tangents.*—The publication of Despretz's memoir on the compass of tangents has induced Gaugain to undertake a series of measurements with this instrument, which have led to results of some interest. It will be remembered* that Despretz took the trouble to demonstrate a fact with which the readers of elementary German treatises on physics have long been familiar, namely, that in the ordinary compass of tangents of Pouillet or Weber, the intensities of the currents are only proportional to the tangents of the angles of deviation when the needle is very short in comparison with the diameter of the metallic ring through which the current passes. Gaugain has found by experiment—what indeed had long been known—that to render the proportionalities of the intensities to the tangents very nearly exact, it is only necessary to place the centre of the magnetic needle out of the plane of the current and in the line perpendicular to the centre of this plane. It was found as the direct result of these experiments, that when we submit a magnetized needle to the action of a circular current, and when the distance from the centre of the needle to the plane of the current is one-fourth of the diameter of the current, the tangents of the angular deviations are almost exactly proportional to the intensi-

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* This Journal, xv, 266, March, 1853.

ties. In order to form tangent galvanometers of great sensibility, Gaugain proposes to place the centre of the needle at the apex of a right cone, the angle of which can easily be determined for a needle of any given length. If the surface of the cone be wound with wire covered with silk, each spire will produce a deviation, the tangent of which will measure the intensity of the current, and the conical multiplier thus formed will of course enjoy the same property. The results obtained by Gaugain have been submitted to an analytical investigation by Bravais, who has found that they are readily deduced from Ampere's theory, and that the error committed in supposing an exact proportionality is very small when the radius of the circle is not less than three times the length of the needle. In the case of a needle the length of which is one-sixth of the radius this error would be about $\frac{1}{1250}$ of the whole intensity.—*Comptes Rendus*, xxxvi, 191, *Jan.* 24, 1853.

2. *On the double refraction produced by compression in Crystals belonging to the regular system.*—Wertheim has communicated the results of a second investigation* of this subject, which are as follows:

(1.) Every mineral species belonging to the regular system has a constant co-efficient of elasticity determinable with sufficient accuracy by means of the fundamental tone which is given by plates vibrating transversely with both ends free.

(2.) Crystals which exhibit only the faces of the cube, behave like homogeneous bodies toward external forces. Under equal circumstances the same force always produces an equal difference of path between the extraordinary and the ordinay ray, whatever be the direction in which the force acts, provided only that it is always perpendicular to the surfaces of the crystal.

(3.) In the case of rock salt and fluor spar, which crystallize in cubes, the difference of path for an equal linear compression is almost the same as in different species of glass; the specific doubly refracting power is also the same.

(4.) Alum, which crystallizes in cubo-octahedra, does not behave like an optically homogeneous body, although its elasticity is equal in all directions. The forces which must be applied to produce an equal difference of path often vary as 1 : 4 according to the direction in which they act.

(5.) It has already been shown that in alum the optical and mechanical axes do not coincide; this displacement takes place as if the position of the optic axes had been traced beforehand within the crystal; it is exhibited toward the right or toward the left of the observer according as the one or the other of the two faces traversed by the ray is turned toward him.

(6.) This displacement is the more considerable in pieces perpendicular to the faces of the cube, the less regularly these faces are formed: it is zero or almost zero in crystals with the square faces of the cube, but it increases in proportion as these faces differ from the form of a square, and it is often from 20° to 25° when, in consequence of one of these accidents of formation which we usually consider as

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* This Journal, xiii, 411, May, 1852.

of no account, one of the sides of the rectangle is almost twice as long as the other.

(7.) The displacement does not occur in all the six positions of the parallelopiped, but only in the two positions in which the ray is perpendicular to the faces of the cube.

(8.) On the contrary we observe displacements in all the six positions when the parallelopiped has been cut perpendicularly to the octahedral faces of the crystal, but these displacements are of different magnitudes.

(9.) All these phenomena; the unequal optical compressibility as well as the rotation of the optical ellipsoid, appear to have their origin in the permanent effects produced by tensions or pressures which take place in the act of crystallization; we know that the mechanical or molecular elasticity is independent of the changes of form which the body has previously undergone; but the optical elasticity preserves as it were the impression.

(10.) An octahedron of fluor spar presented an example of a displacement of 45°, while cubic crystals of the same mineral offered no trace of it; this fact evidently supports the hypothesis just expressed.

(11.) All the facts which we observe when we employ compression to convert crystals of the regular system into repulsive doubly refracting crystals, are reproduced in a precisely similar manner which we use extension to convert them into positive crystals.—*Comptes Rendus*, xxxv, 276.

3. *On the Electrolytic Law.*—Buff has taken up the consideration of Faraday's law of electrolytic action, and has demonstrated by careful measurements that no portion of electricity however small, can traverse an electrolyte without decomposing an equivalent of the same. By a peculiar arrangement of Daniell's battery, Buff obtained a current which was perfectly constant for several months. The fluid electrolyte was a solution of nitrate of silver, the electrodes were plates of pure silver, and the loss of weight of the positive and gain in weight of the negative electrode were determined by the balance and found to agree extremely well. The results obtained by the electrolysis of a solution of sulphate of copper were also found to correspond satisfactorily, the quantity of copper deposited upon the negative pole being compared with the quantity of silver deposited at the same time from a silver solution. The almost perfect correspondence of the quantities of silver dissolved at one electrode and deposited at the other, as well as the equivalent proportionality between the silver deposited in one electrolytic cell and the copper deposited in another, furnish the most satisfactory proof yet given of the accuracy of Faraday's law.—*Ann. der Chemie und Pharmacie*, lxxxv, 1, *Jan.*, 1853.

4. *Products of the fermentation of Citrate of Lime.*—Personne has studied the fermentation of citrate of lime both in the raw state, as produced by saturating lemon juice with chalk, and as obtained by employing pure materials and adding yeast to bring on the fermentation. The decomposition of the salt proceeds pretty rapidly; the gas evolved is a mixture of carbonic acid and hydrogen; the filtered liquid after the citrate of lime has disappeared yields a white soluble lime salt, which, decomposed by nitrate of silver, gives crystalline silver salts

which on analysis proved to be mixtures of acetate and butyrate of silver. The products of the fermentation of citric acid are therefore hydrogen, carbonic, acetic, and butyric acids, and the decomposition may be represented by the equation

$$4(C_{12}H_3O_{11}, 3HO)+4HO=3(C_4H_4O_4)+2(C_8H_8O_4)+20\,CO_2+8H.$$

It is however possible that lactic acid is an intermediate product in this decomposition and that this acid by a further decomposition yields hydrogen, butyric, and carbonic acids.—*Comptes Rendus*, xxxvi, 197.

5. *On the compounds of Glycerine with Acids.*—BERTHELOT has succeeded in preparing a number of compounds analogous to the natural fats and oils, by the method employed by Pélouze and Gélis in obtaining butyrine, and which is in fact identical with that commonly used in etherifying the fatty acids. The acid is mixed with syrupy glycerine, the mixture heated to 100° and a current of chlorhydric acid passed into the liquid during several hours, the mixture being kept at 100°: the whole is then allowed to cool in the current of gas and then abandoned for hours, days, or even weeks. The mixture is then saturated with carbonate of soda and purified by washing. The acetic combination thus produced is a colorless oil with an agreeable odor and yields glycerine and acetic acid by saponification. The author obtained also *valerine* (phocérine of Chevreul), benzoicine and sebacine. —*Comptes Rendus*, xxxvi, 27.

6. *Alkaloids in Opium.*—ANDERSON has analyzed several of the rarer alkaloids contained in opium and established their formulas by the examination of their platinum salts. Narcein is found to have the formula $C_{46}H_{29}NO_{18}$, while thebain is represented by $C_{38}H_{21}NO_6$; both these bases give well defined crystalline salts. By the action of nitric acid narcotin was found to yield cotarnin and a new substance which the author terms opianyl represented by $C_{20}H_{10}O_8$. Opianic acid was found to have the formula $C_{20}H_{10}O_{10}$. Hemipinic acid proves to be bibasic and is represented by the formula $C_{20}H_8O_{10}+2HO$. By the action of nitric acid upon cotarnin the author obtained the apophyllenic acid of Wöhler, and found it to be $C_{16}H_7NO_8$, so that it differs from anthranilic acid only by $2CO_2$.—*Journal für prakt. Chemie.*

7. *On the constitution of Mutton Tallow, Human Fat and Spermaceti.*—HEINTZ has published a continuation of his researches upon the fatty acids and has arrived at interesting and important results. These results in the author's words are as follows:

(1.) The fluid portion of mutton tallow has the same constitution as the corresponding portion of human fat. It consists essentially of olein but contains another fluid fat in small quantity, which yields by saponification a fluid acid having a lower equivalent weight than oleic acid.

(2.) The solid portion of mutton tallow consists of stearin and palmitin; by its saponification we obtain only stearic and palmitic acids.

(3.) The constitution of stearic acid is not represented by the formula $C_{68}H_{66}O_5+2HO$, but by $C_{36}H_{25}O_3+HO$.

(4.) Stearate of soda is $C_{36}H_{35}O_3$, NaO, and the stearates of copper, lead, silver, magnesia and baryta, have a similar constitution and are anhydrous.

(5.) Stearic ether is not an acid compound, but is simply $C_{36}H_{35}O_3 + C_4H_5O$.

(6.) Anthropic acid is a mixture of about 7 parts of palmitic acid and 5 parts of stearic acid.

(7.) Margaric acid is a mixture of about 10 parts of palmitic with 1 part of stearic acid.

(8.) The solid portion of human fat consists only of stearin and palmitin. In this fat palmitin predominates while stearin makes up the great mass of mutton fat.

(9.) Neither stearophanic nor margaric acids are contained among the products of the saponification of spermaceti. The acids resulting from this saponification are the stearic, palmitic, cetic, myristic and cocinic.

(10.) The supposed pure ethal is a mixture of two alcohols, Ethal and Stethal (hydrate of oxyl of cetyl and hydrate of oxyd of stethyl).

(11.) Ethal consists of $C_{32}H_{33}O + HO$ and Stethal of $C_{36}H_{37}O + HO$.

(12.) Spermaceti consists of compounds of the oxyds of cetyl and stethyl with stearic, palmitic, cetic, myristic and cocinic acids.—*Pogg. Ann.*, lxxxvii, 553, No. 12, 1852. W. G.

8. *On the manufacture of Glycerin ;* by CAMPBELL MORFIT, M.D.—Glycerin is generally made, on the large scale, either by directly saponifying oil with oxyd of lead ; or from the "waste," or spent leys of the soap makers. The first mode of obtaining it is complex and expensive, while in the latter, the difficulty of wholly separating the saline matters of the "waste" renders it impossible to obtain a perfectly pure product. In view of these obstacles, and the increasing demand for the article, both in medicine and perfumery, I submit a new process which has been found, by actual practice, to combine the great and desirable advantages of economy of time, labor and money.

Take one hundred pounds of oil ; tallow, lard or "stearin," (pressed lard,) place it in a clean iron bound barrel, and melt it by the direct application of a current of steam. While still fluid and hot, add 15 pounds of lime, previously slaked and made into a milk with 2½ gallons of water, then cover the vessel, and continue the steaming for several hours, or until the completion of the saponification. This is known when a sample of the resulting and cooled soap gives a smooth and lustrous surface on being scraped with the finger nail, and breaks with a cracking noise. By this treatment, the fat is decomposed, its acids unite with the lime to form insoluble lime soap, while the eliminated glycerin remains in solution in the water along with the excess of lime. After it has been sufficiently boiled, it is allowed to cool and settle, and is then to be strained through a crash cloth.

The soap is reserved for sale to stearic candle makers, or else may be reconverted into saleable fat by the process given at pp. 432–445 Morfit's "*Applied Chemistry.*"

The strained liquid contains only the glycerin and excess of lime. It must be carefully concentrated by steam heat. During evaporation, a portion of the lime is deposited on account of its lesser solubility in hot than in cold water. The remainder is removed by treating the evaporated liquid with a current of carbonic acid gas, boiling by steam heat to convert any soluble *bi*-carbonate of lime that may have been formed, into insoluble neutral carbonate, allowing repose, decanting or straining off the clear supernatant liquid from the precipitated carbonate of lime, and further evaporating, as before, if necessary, to drive off any excess of water.

As nothing fixed or injurious is employed in the process, the glycerin, thus prepared, will be absolutely pure.

Baltimore, Md., March, 1853.

III. MINERALOGY AND GEOLOGY.

1. MINERALOGICAL NOTICES, No. V.

(1.) *New Works.*

Das Krystallo-chemische Mineralsystem von GUSTAV ROSE, 156 pp. 8vo, with 10 wood-cuts. Leipzig, 1852.—A classified catalogue of minerals, based on the system of Berzelius, with their chemical formulas, follows an introductory chapter of 16 pages. The classification includes the following grand divisions,

I. Simple bodies: with the subdivisions, (1) Tesseral, (2) Dimetric, (3) Rhombohedral, (4) Trimetric and Clinohedral.

II. Compounds of Antimony, Arsenic, Tellurium, Sulphur and Selenium.

III. Compounds of Chlorine, Fluorine, Bromine and Iodine.

IV. Oxygen compounds, divided into (A) binary compounds, (B) not binary; the latter subdivided into (*a*) compounds of R^2O, or RO; (*b*) of R^2O^3; (*c*) of RO^2—carbonates; (*d*) of R^2O^5—phosphates and arseniates; RO^3—(*e*) silicates, sulphates, chromates, molybdates, tungstates, tantalates, niobates, pelopates.

This classification is followed by notes on the crystallization and composition of many of the species. The remainder of the volume is a catalogue of minerals, following the same classification, but in which the species under each division are arranged in columns according to their system of crystallization.

Elemente der Mineralogie, von Carl FRIEDERICH NAUMANN, Professor an der Univ. Leipzig. 3d edit. 448 pp. 8vo, with 385 wood-cuts. Leipzig, 1852.—Prof. Naumann in his excellent work, commences with crystallography, the elements of which are presented without entering into mathematical formulas. The physical and chemical characters and classification of minerals occupy the next 90 pages, and are treated with much detail and system. In his classification of species, which is related to that of Mohs, he adopts 16 classes:—I. Hydrogenoxyd; II. Hydrolytes; III. Chalcites; IV. Haloids; V. Earths; VI. Geolites; VII. Amphoterolites; VIII. Chalcolites; IX. Tantalitoids; X. Metalloxyds; XI. Metals; XII. Glances or Galenoids; XIII. Pyritoids; XIV. Cinnabarites or Blendes; XV. Thiolites; XVI. Anthracides. The arrangement is quite similar to that adopted (as a modification of Mohs's system) in the 1st and 2nd editions of Dana's Mineralogy. The author enumerates and describes 643 species of minerals, giving the crystallography and chemical characters of each briefly but with precision, and mentioning the prominent localities.

Lehrbuch der Krystallkunde oder Anfangsgründe der Krystallographie, Krystallophysik, und Krystallochemie, von C. F. Rammelsberg, Dr. und Professor an der Universität zu Berlin, etc. 236 pp. 8vo, with 250 wood-cuts.—This work is a Text-book of elementary Crystallography, in which the subject is presented with clearness, and well illustrated with figures. The Chapter on Isomorphism and other points in chemical crystallography, give special value to the work.

Owen's Report on the Geological Survey of Wisconsin, Iowa and Minnesota. Noticed in this volume, p. 296.

Foster and Whitney's Report on the Lake Superior Region, 2nd Part. Noticed in this volume, p. 295.

Elementos de Mineralogia, par Ignacio Domeyko, Membro de la Universidad de Chile, Professor de quimica y mineralogia en el Colegio de Coquimbo. 382 pp. 8vo. Serena, 1845.—This valuable manual is dedicated to the youths of Chile. No one has done so much towards developing the mineralogy of that country as Prof. Domeyko; and his researches have been rewarded by the discovery of several new species. His work has a special value on account of its fullness upon the ores and mineral products of his adopted land.

(2.) *New Species.*

On Osteolite, a new mineral near Apatite; by C. Bromeis, (Ann. Ch. Pharm., lxxix, 1; in Ausz. Pharm. Centr., 1851, 901; here from Lieb. u. Kopp's Jahresb. f. 1851, p. 813.)—Osteolite is externally a chalky or clay-like mineral, not becoming plastic in water. Within, it is fine granular or compact and resembles lithographic stone. Taste like clay, and adheres to the tongue. BB. acts like pure phosphate of lime. Nitric and hydrochloric acids dissolve it, producing a little gelatinous silica. Analyses (I) by Bromeis, the compact part; (II) the earthy by Ruetz; (III) the intermediate, by Ewald, under Bunsen's direction.

	$\overset{:\cdot:}{\text{P}}$	$\dot{\text{Ca}}$	$\dddot{\text{Si}}$	$\overset{\dots}{\bar{\text{Fe}}}$	$\overset{\dots}{\bar{\text{Al}}}$	$\dot{\text{Mg}}$	$\dot{\text{K}}$	$\dot{\text{Na}}$	$\ddot{\text{C}}$	$\dot{\text{H}}$
I.	36·88	49·41	4·50	1·85	0·93	0·47	0·76	0·62	1·81	2·28= 99·51
II.	37·41	49·24	2.75	2·78	1·25	0·79	0·81	0·46	2·34	3·45=101·28
III.	37·16	48·20	2·03	2·31	*trace*	1·85	0·73	0·43	2·55	3·62= 98·80

Also a trace of chlorine in No. 1. The mineral contains therefore 86 p. c. of phosphate of lime ($\dot{\text{Ca}}^3\overset{:\cdot:}{\text{P}}$), but fails in the fluorid and chlorid which characterizes apatite. It is a product proceeding from the alteration of dolerite.

Dimorphin, from a Fumarole of the Solfatara, Phlegræan Fields; A. Scacchi, (Mem. Geol. Sulla Campania, Mem. iii, and J. f. pr. Chem., lv, 56.)—Dimorphin is a sulphuret of arsenic; the exact constitution has not been ascertained, but Scacchi deduces from his researches, $As^2 S^3$, which would give 24·55 of sulphur and 75·45 of arsenic. Occurs in small orange yellow trimetric crystals of adamantine lustre; powder saffron yellow. G.=3·58.

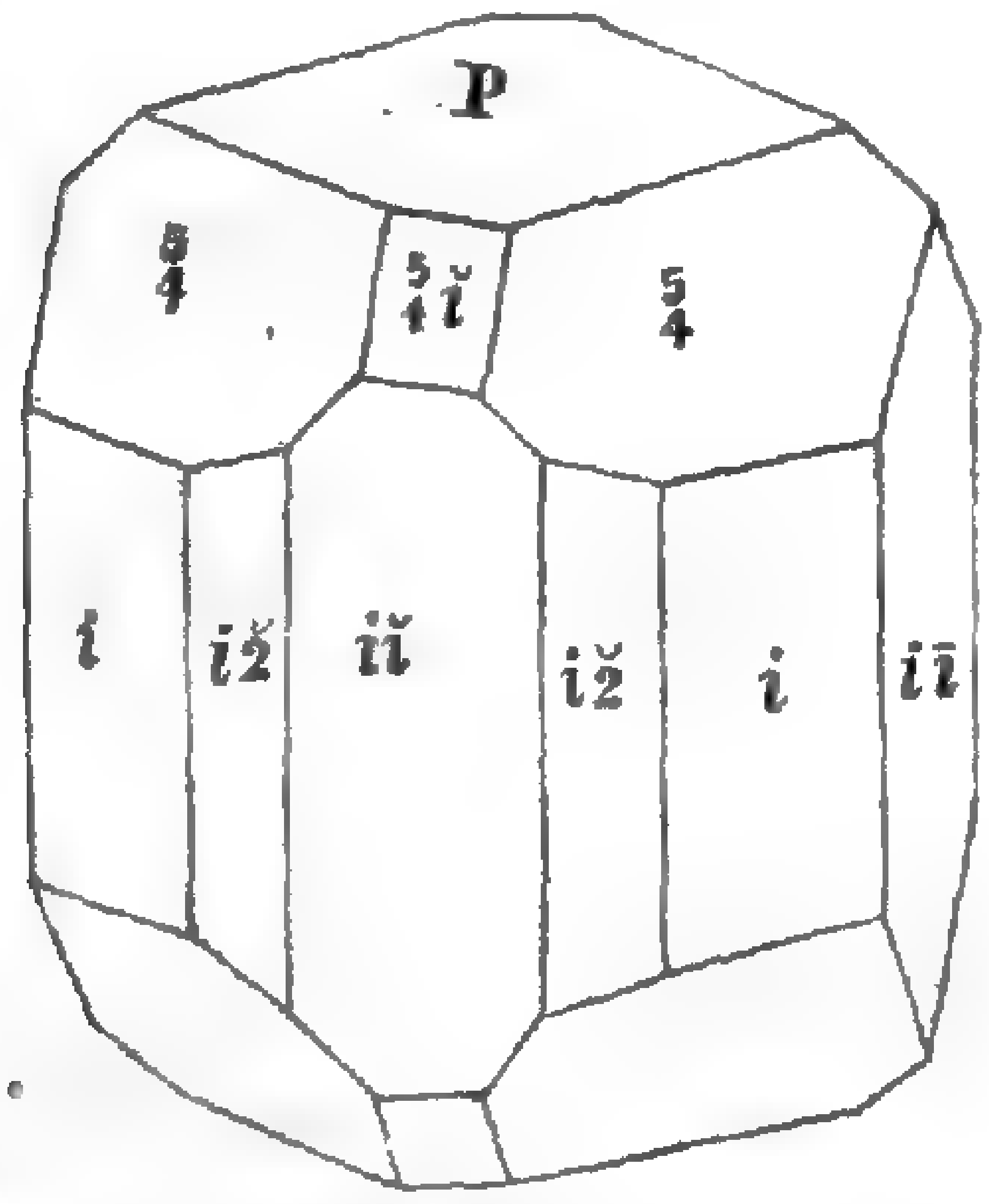
A. Scacchi distinguishes two types of crystals, represented in figures 1 and 2 (copied with a different lettering).

The vertical and two lateral axes have—

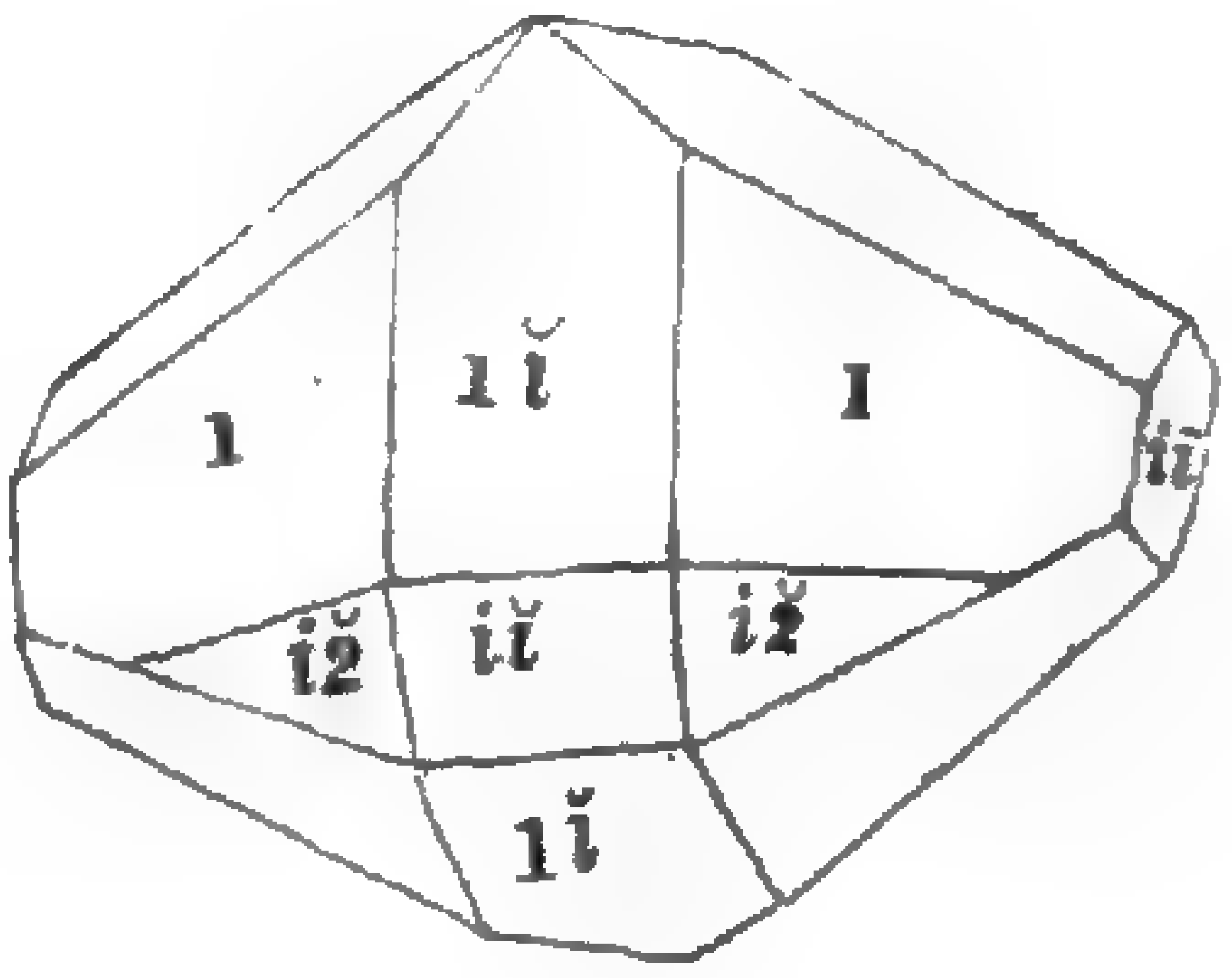
In one, the ratio $a : b : c = 1 : 1{\cdot}287 : 1{\cdot}153$.
In the other, " $a : b : c = 1 : 1{\cdot}658 : 1{\cdot}508$.

The first affords the vertical prisms 121° 38′ and 96° 20′; the octahedron 119° 14′, 111° 10′, 98° 40′; the brachydiagonal prism (basal angle of prism) 75° 40′.

1.



2.



In the second, there is the vertical prism 122° 14′ (calculated, 121° 48′ observed); the octahedron 126° 40′, 120° 40′, 83° 52′; the brachydiagonal prism 62° 12′.

[If we make $b=1$ in the above ratios for the axes, then

For Type I, $a : b : c = 1 : 1{\cdot}287 : 1{\cdot}153 = 0{\cdot}777 : 1 : 0{\cdot}896$.
For Type II, $a : b : c = 1 : 1{\cdot}658 : 1{\cdot}508 = 0{\cdot}663 : 1 : 0{\cdot}903$.

The two types differ therefore almost solely in their vertical axes; for the slight difference in the ratio of the lateral axis is within the limits of error of observation. The ratio of 603 to 777 is nearly as $1 : 1\frac{1}{4}$. If this ratio were exact, it is obvious that the two types would have the same vertical axes, and the difference would be simply a difference in the secondary planes, the octahedron of one being $\frac{5}{4}$P, that of the other 1P. But this ratio is not exact. Adding to 603 its fourth, it becomes 754; and adopting $\frac{5}{4}$ and 1 as the true expressions for the secondary planes mentioned, the two types will differ in the vertical axes, by the small difference between 0·777 and 0·754, and this is in accordance with known differences in other cases dependent on isomorphous substitutions. The axes will then be as follows:—

Type I, $a : b : c = 0{\cdot}777 : 1 : 0{\cdot}896$.
" II, $a : b : c = 0{\cdot}754 : 1 : 0{\cdot}903$.

The planes in this case will have the symbols given on the figures (copied, except the lettering, from Scacchi), in which the crystal of type I has for its octahedron, $\frac{5}{4}a : 1b : 1c$, and that of type II, $1a : 1b : 1c$. The figures have the shorter lateral axis parallel to the observer.—J. D. D.] In figure 1, according to Scacchi, the angle $P : \frac{5}{4}\breve{i} = 142° 10'$; $P : \frac{5}{4} = 130° 40'$; $i\breve{i} : \breve{i}2 = 150° 49'$; $i\breve{i} : i = 131° 50'$.

Melinophane, a new mineral; Th. Scheerer, (J. f. pr. Chem., lv, 449.)—This species is near Leucophane and possibly identical with it. Its color is sulphur yellow, citron or honey yellow; lustre vitreous; hardness 5; G.=3·00. Only one distinct cleavage. Composition—

$\dddot{Si}$	$\ddot{\overline{Be}}$	$\dddot{\overline{Al}}$	$\dddot{\overline{Mn}}$ ($\dot{Mn}$?)	$\dddot{\overline{Fe}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Na}$	F
44·8	2·2	12·4	1·4	1·1	31·5	0·2	2·6	2·3

with 0·3 of niobic acid, zirconia, oxyd of cerium and yttria=98·8. It comes from the zircon-syenite of Frederiksvärn, Norway, along with elæolite, black mica, violet-blue fluor and magnetic iron.

Sunadin, or glassy feldspar.—Naumann recognizes this as a distinct species (Min. 3d edit., p. 300). It is monoclinic like orthoclase; but the angle of the rhombic prism is 119° 13′, and the inclination of the axis 63° 55′ (65° 47′ in orthoclase). Formula same as for orthoclase, but often contains lime and magnesia. Common in trachyte and phonolite.

Montmorillonite.—This name is given by Salvetat to a species near Halloysite, analyzed by Damour, from Montmorillon, Department of La Vienne. Formula $\dddot{\mathrm{Al}}\,\dddot{\overline{\mathrm{Si}}}{}^3+6\dot{\mathrm{H}}$.

On Scleretinite, a new Fossil Resin, from the coal measures of Wigan, England; by J. W. Mallet, (Phil. Mag. [4], 4, 261.)—Occurs in small drops or tears from the size of a pea to that of a hazel-nut. Brittle, with the fracture chonchoidal. Translucent in thin splinters. Color black, but by transmitted light reddish brown; streak cinnamon-brown. Lustre between vitreous and resinous, rather brilliant. G.=1·136. H.=3. Heated on platinum foil it swells up, burns like pitch, with a disagreeable empyreumatic smell and a smoky flame, leaving a coal rather difficult to burn, and finally a little gray ash. In a glass tube, yields a yellowish-brown oily product of a nauseous empyreumatic odor. Insoluble in water, alcohol, ether, caustic and carbonated alkalies or dilute acids; and even strong nitric acid acts slowly. Composition:—

	Carbon.	Hydrogen.	Oxygen.	Ash.
1.	76·74	8·86	10·72	3·68
2.	77·15	9·05	10·12	3·68

affording the ratio $C^{10}H^7O$=carbon 77·05, hydrogen 8·99, oxygen 10·28, ash 3·68. Taking the number of atoms of carbon at 40, which exists in so many resins, the formula becomes $C^{40}H^{28}O^4$. It is nearest in composition to amber, which contains $C^{40}H^{32}O^4$.

(3.) *Described Species.*

Diamond.—The diamond has been found in the Australian gold region.

Misenite, a hydrous sulphate of potash from Misene, Phlegræan fields; A. Scacchi, (Memorie geologiche sulla Campania, Mem. iii, and J. f. pr. Chem., lv, 54).—The Misenite is from a hot cavern at Misene, and occurs in silky fibres of a dirty white color. Melts easily when heated and gives out water. Composition:—

$\overline{\mathrm{S}}$	$\dot{\mathrm{K}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{H}}$
56·93	36·57	0·38	6·12

Formula, $\dot{\mathrm{K}}\,\overline{\mathrm{S}}+\dot{\mathrm{H}}\,\overline{\mathrm{S}}$.

Trona.—Efflorescences of Trona or salæratus occur near the Sweetwater River, Rocky Mountains, mixed with sulphate of soda and chlorid of sodium. Three grammes of the salt in dry powder afforded

Dr. L. D. Gale 0·9030 of carbonic acid corresponding to 1·73239 grammes of the sesquicarbonate. (Stansbury's Rep., p. 420.)

Alum from Alum Point, Great Salt Lake. This alum is found by Dr. L. D. Gale (Stansbury's Report, &c., p. 420) to be a manganese alum, and crystallizes in acicular 4-sided (?) prisms. Taste like that of ordinary alum but less strong. It occurs as an efflorescence on a slate rock. The specimen received by Dr. L. D. Gale was recrystallized before analysis, as it had lost part of the water. It afforded in an imperfect analysis

$\dot{H}$	$\dot{Mn}$	$\dddot{\bar{A}}l$	$\dddot{S}$
73·0	8·9	4·0	18·0

Heavy Spar.—Analysis of a crystalline variety from Thurnberg near Durlach, by E. Riegel, (Jahrb. pr. Pharm., xxiii, 348; Lieb. u. Kopp's Jahresb. f. 1851, p. 815.)

$\dot{Ba}\dddot{S}$	$\dot{Sr}\dddot{S}$	$\dddot{Si}$	$\dddot{\bar{F}}e$	$\dot{H}$
93·92	0·86	3·75	0·64	0·50=99·67

Arragonite of Thurnberg, near Durlach.—Analysis by E. Riegel, (ibid)—carbonate of lime 96·04, carb. strontian 2·20, $\dddot{\bar{F}}e$ 0·06, water 0·32=98·62.

Calc Spar.—The crystallography of calc spar has been revised with great thoroughness by F. X. M. Zippe. The whole number of distinct forms is 127, viz: 36 rhombohedrons, 79 scalenohedrons, 7 pyramids, and 5 prismatic including the terminal plane. (Denkschriften der mathem.-naturw. Classe d. kais. Acad. d. Wissensch. in Wien, Bd. iii; and Lieb. u. Kopp's Jahresb. f. 1851, p. 817–820.)

The Carrara Marble, of best quality, afforded P. M. Kæppel, on analysis, (J. f. pr. Chem. lvii, 324), carbonate of lime 98·7654, carbonate of magnesia 0·9002, silica (0·0059) trace of phosphoric acid and loss 0·0961, oxyds of iron and manganese and alumina 0·0825, quartz sand 0·1558=100.

Limestones.—Analyses of Silurian limestones of the Lake Superior region, by Foster & Whitney, loc. cit. p. 192. The limestones contain for the most part a large amount of magnesia.

Marble of Lake Superior Region; Foster & Whitney's Rep., loc. cit., p. 83.

Selenite.—Crystals of Selenite are common in connection with an impure limestone in the Des Moines country, Iowa. D. D. Owen, Rep. Geol. Survey, Wisconsin, etc., 1852, p. 98.

On Lancasterite and Magnesite; J. L. Smith, and G. J. Brush.—This vol., p. 213, 214.

Apatite.—C. Rammelsberg has analyzed the pseudo-apatite of Breithaupt, and obtained the following constitution, showing that it is an impure apatite (J. f. pr. Chem. lv, 486).

$\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}}$	$\dot{Ca}$	$\dot{Ca}$	$\dot{Mg}$	$\dddot{\bar{F}}e$	$\ddot{C}$ & loss
40·30	48·38	5·40	0·14	1·78	4·00

The fluorine was not determined. Only a trace of chlorine was detected.

Phosphate of lime nodules in Silurian rocks of Canada.—W. E. Logan in Rep. Progress of Geol. Survey of Canada, 1852, p. 28; with analyses by T. S. Hunt, p. 105. This volume, p. 129.

On Childrenite; C. Rammelsberg, (Pogg. Ann., lxxxv, 435).—This rare mineral is trimetric, with the axes 0·67113 : 1 : 0·63912. The crystals are yellow, yellowish brown, and brownish black, and form druses on spathic iron. G=3·28–3·247. H=5. Gives on heating much water, colors the blowpipe flame bluish green, and with the fluxes gives the reaction of iron and manganese. Dissolves in muriatic acid in powder after long digestion, and the solution contains phosphoric acid, alumina, and the oxyds of iron and manganese. Analysis:

	$\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\text{P}}}$	$\overset{\cdot\cdot\cdot}{\overline{\text{Al}}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$
	28·92	14·44	30·68	9·07	0·14	16·98
Oxygen	16·20	6·74	6·81	2·03	0·14	15·09

Oxygen ratio for acid, peroxyd, protoxyds and water, 15 : 6 : 8 : 15, giving the formula $(2\,\dot{\text{R}}_4\,\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\text{P}}}+\overset{\cdot\cdot\cdot}{\overline{\text{Al}}}{}^2\,\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\text{P}}})+15\dot{\text{H}}$.

Quartz.—A large 6-sided prism, 2 feet long, as stated by Prof. C. U. Shepard, now weighing 175 pounds, was found at Waterbury, Vt. by Mr. M. M. Carleton. The width of the broadest prismatic planes is 14 inches, of the others, 8 and 9 inches.

Opal.—Analyses by G. Bischof (Lehrb. d. Chem. u. Phys. Geol., ii, 1837, Liebig und Kopp's Jahresb, for 1851, 762) of I, a brown shining opal from Trachyte of Rosenau in the Siebengebirge; II, a dull yellowish, ib.; III, a yellow, ibid,—after ignition:

	$\dddot{\text{Si}}$	$\overset{\cdot\cdot\cdot}{\overline{\text{Al}}}$	$\overset{\cdot\cdot\cdot}{\overline{\text{Fe}}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{K}}$		
I, *a*	96·12	0·50	3·30	*trace*	0·08	——	=100—loss by ignition	5·11
I, *b*	96·00	3·49		——	0·40	0·06	=100 " " "	5·00
II, *a*	94·49	0·60	4·85	*trace*	0·60	——	=100 " " "	6·77
II, *b*	94·67	5·26		——	0·02	0·05	=100 " " "	5·95
III,	95·55	4·37		——	——		= 99·92	

Magnesian Opal, from near Harmanjick, Asia Minor.—J. Lawrence Smith obtained for the composition of this opal, which occurs with serpentine and carbonate of magnesia,

Silica 92·00, Water 4·15, Magnesia 3·00.

It occurs also on the island of Mytilene.

Datholite of Isle Royal.—Analysis of the massive variety by Foster and Whitney (loc. cit., p. 101).

$\dddot{\text{Si}}$	$\dot{\text{Ca}}$	$\overset{\cdot\cdot\cdot}{\overline{\text{B}}}$	$\overset{\cdot\cdot\cdot}{\overline{\text{Mn}}}$	$\dot{\text{H}}$
37·64	34·68	21·88 (loss)	*trace*	5·80

Gymnite.—A serpentine mineral from the Tyrol, described by Liebener and Vorhausen, examined by J. Oellacher (Zeitschr. d. deutsch. geol. Gesellsch. iii, 222; im Ausz. Jahrb. d. k. k. geol. Reichsanst. (1850), iv, 608; here from Lieb. u. Kopp's Jahresb. für 1851, p. 804) and F. Kobell (Münch. gelerte Anz. (1851) xxxiii, 1; and ibid) and shown to resemble *gymnite.* It looks like gum arabic, and is brittle, transparent or translucent; color yellowish white to honey-yellow. Taste clayey; adheres a little to the tongue; becomes more transparent in water. H. according to Vorhausen, =2·5—3; G. =1·936—2·155. BB. fuses only on the edges to a white enamel. Easily dissolves in concentrated hydrochloric acid, with a separation of flocculent silica. Analyses:

	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Mg}}$	$\ddot{\bar{\mathrm{Fe}}}$	Apatite	$\dot{\bar{\mathrm{H}}}$
I. By Oellacher,	40·40	35·85	0·38	0·77	22·60=100·00
II. By Kobell,	41·50	38·30	—	—	20·50=100·30

Formula according to Oellacher, $\dot{\mathrm{Mg}}\dddot{\mathrm{Si}}+\dot{\mathrm{Mg}}\dot{\bar{\mathrm{H}}}^3$; Kobell, $\dot{\mathrm{Mg}}^2\dddot{\mathrm{Si}}+3\dot{\bar{\mathrm{H}}}$.

Serpentine in Canada.—Mr. T. S. Hunt gives the following analysis (Logan's Rep.) of a serpentine from Ham—a variety of a greenish white color, subtranslucent; H. 3·5.

$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$, $\ddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Mg}}$ (loss)	$\dot{\bar{\mathrm{H}}}$
43·4	3·6	40·0	13·0

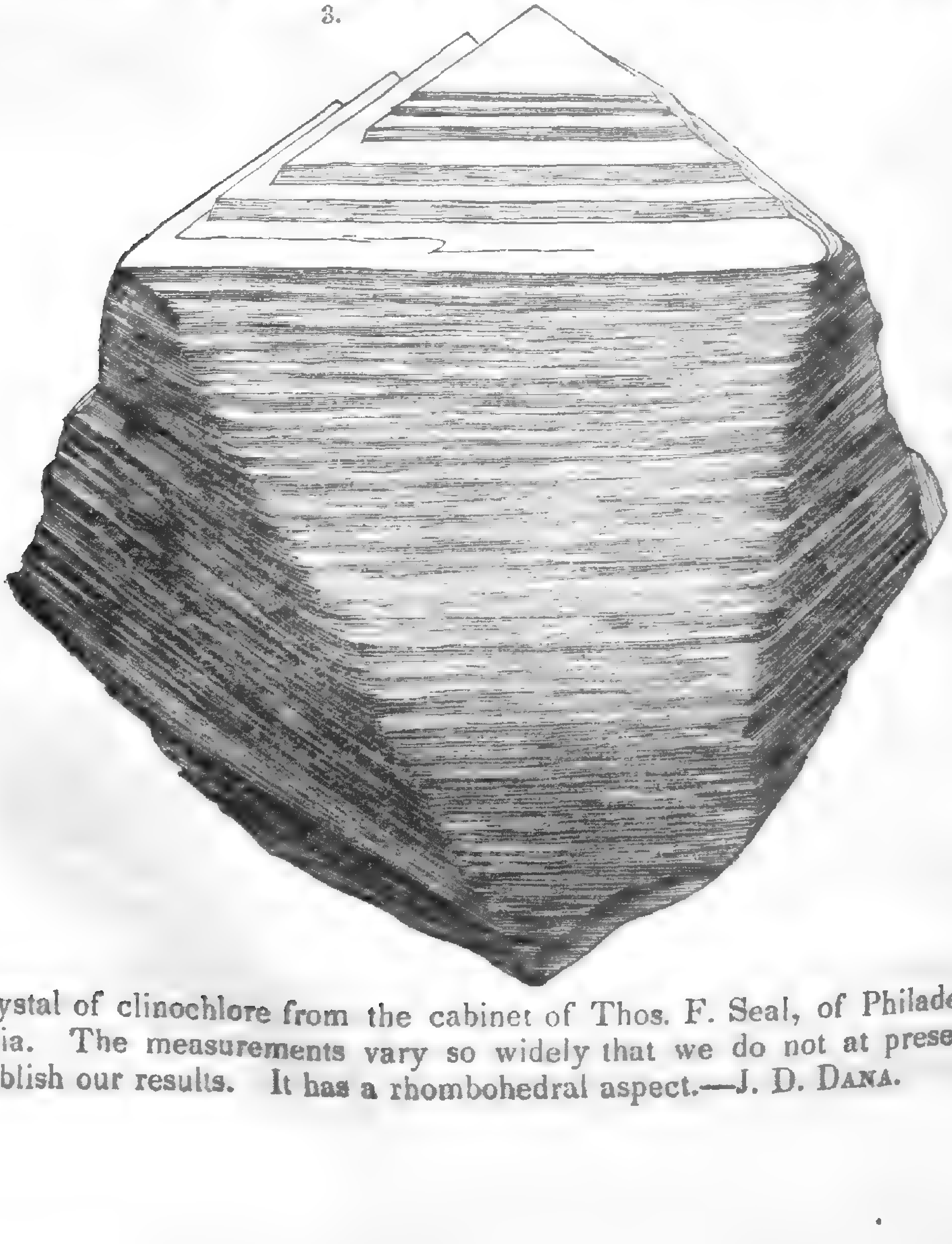
A serpentine of a grayish-green color from Ireland, Canada, afforded Silica 43·70, magnesia 23·46, alumina with peroxyd of iron 23·00, water 11·57=101·73. G. =2·652—2·658. Another serpentine rock from near Nicolet rock, had the specific gravity 2·701.

Kerolite, Bowenite, and Williamsite.—J. Lawrence Smith and G. J. Brush. This vol. p. 211, 212.

Tabergite.—G. Rose thus names Werner's Talc of Taberg in Wermland, which according to Svanberg's analysis is near chlorite.

Clinochlore.—The following is a figure, natural size, of a large crystal of clinochlore from the cabinet of Thos. F. Seal, of Philadelphia. The measurements vary so widely that we do not at present publish our results. It has a rhombohedral aspect.—J. D. Dana.

3.



Pyroxene.—R. Hermann has applied his principles of "Heteromerism" to several minerals referred by him to the Pyroxene series. (J. f. pr. Chem., lvii, 193). The paper hardly admits of an abstract.

On the Chlorite of Achmatovsk, in the Urals.—M. Kokscharov has described and figured some remarkable crystals of the chlorite of Achmatovsk, (Verhandl. der min. Ges. zu St. Petersburg, 1850–1851). The form is rhombohedral, and hemihedrally so (or tetartohedral, to the hexagonal prism.) There is a resemblance in some of them to a common form of specular iron. One of the crystals is nearly 6 millimeters in diameter, and is remarkably perfect and symmetrical in its faces. The others are 1 to 1½ millimeters across. Figures 4, 5, 6 represent two of the crystals. P : R=113° 58′, R : R=75° 22½′, P : $\frac{6}{5}2$=113° 10′, P : $\frac{6}{5}$R ($\frac{6}{5}$ in figure)=110° 20′, $\frac{6}{5}$R : $\frac{6}{5}$R=71° 24′ $\frac{6}{5}$R : R=124° 43′, $\frac{6}{5}$R : $\frac{6}{5}2$=152° 3′, R : $\frac{6}{5}2$=152° 32′, P : $\frac{12}{5}2$=102° 10′, P : $\frac{9}{5}2$=105° 55′. A few of the other angles determined by Kokscha-

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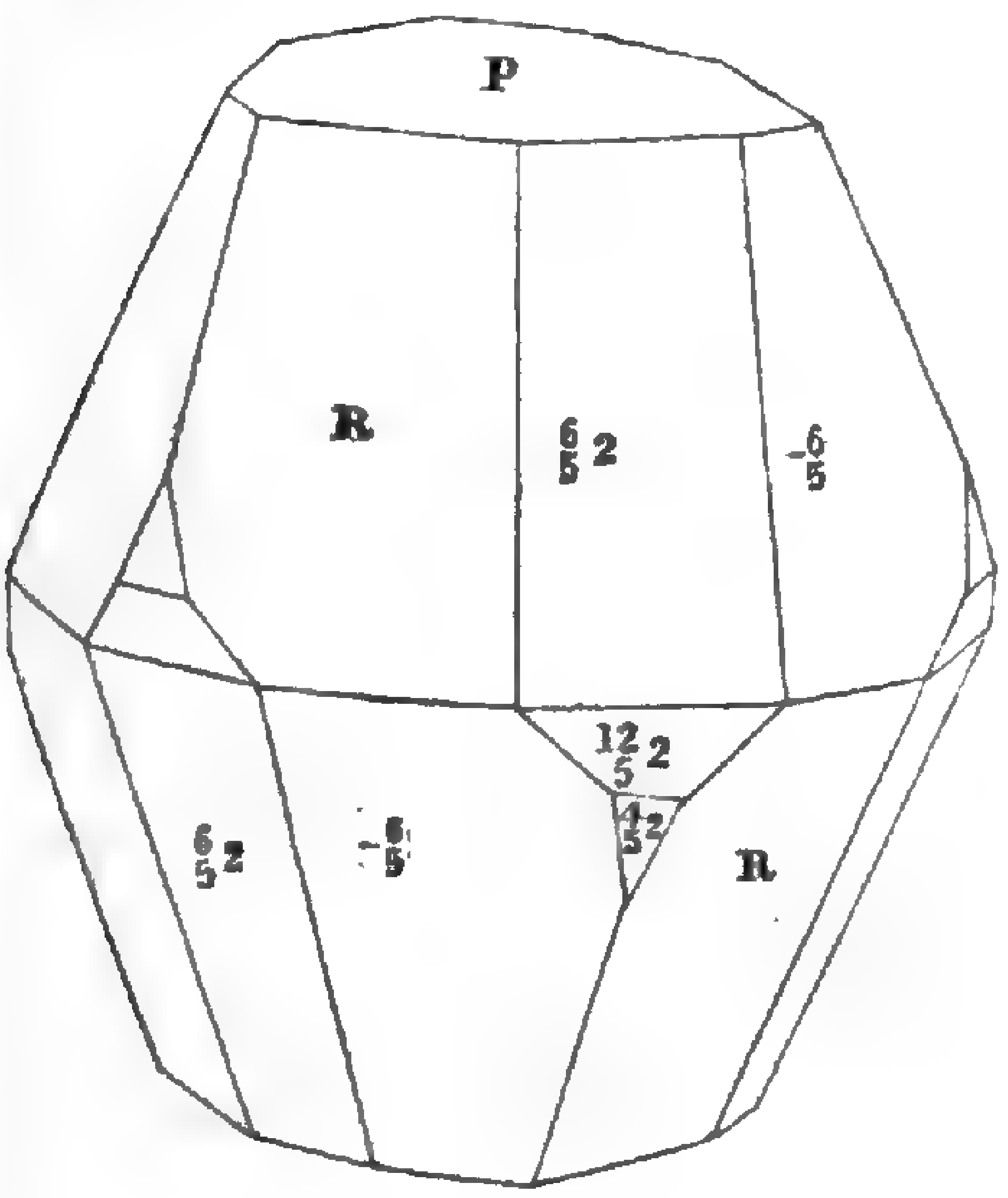

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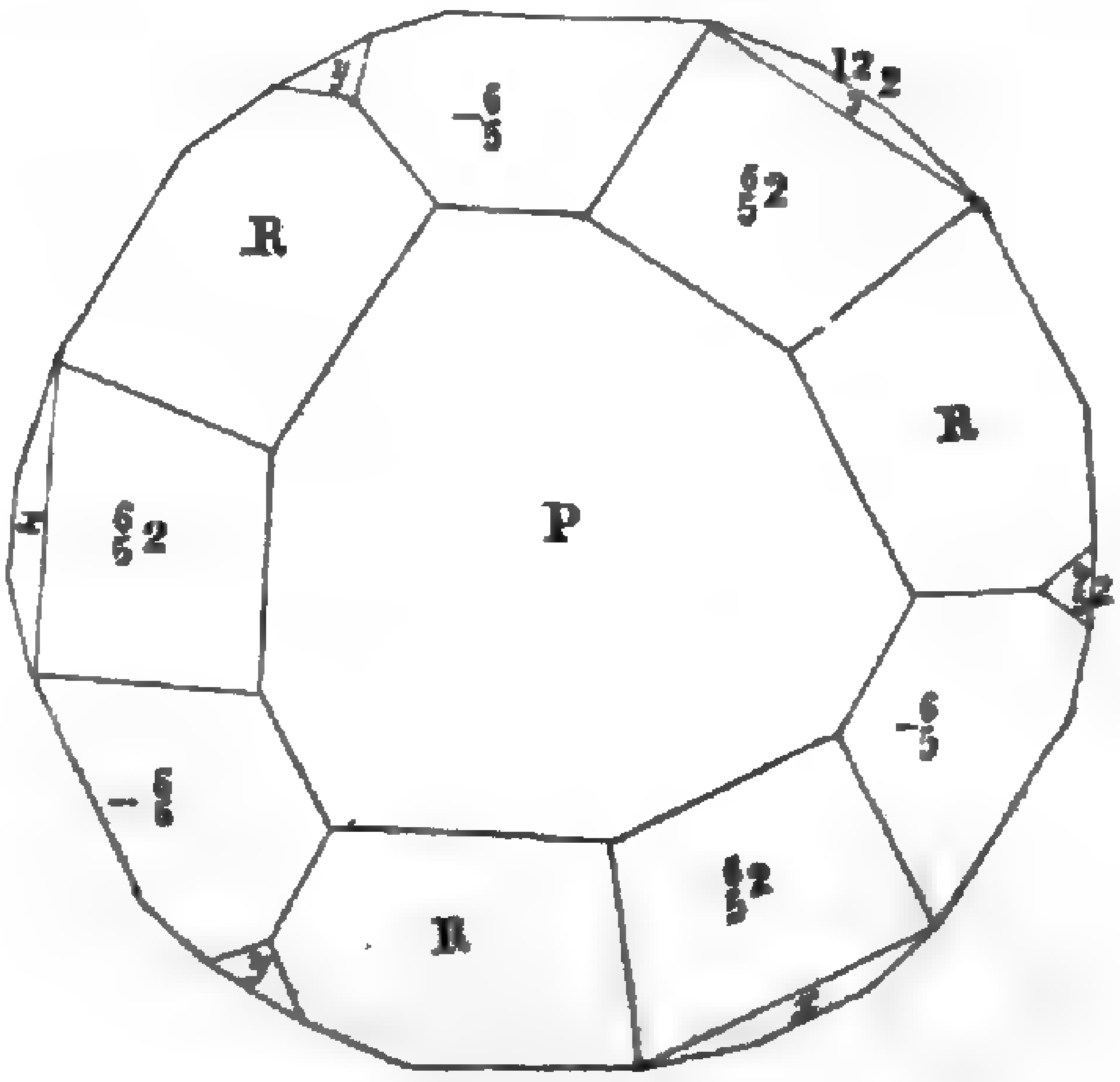

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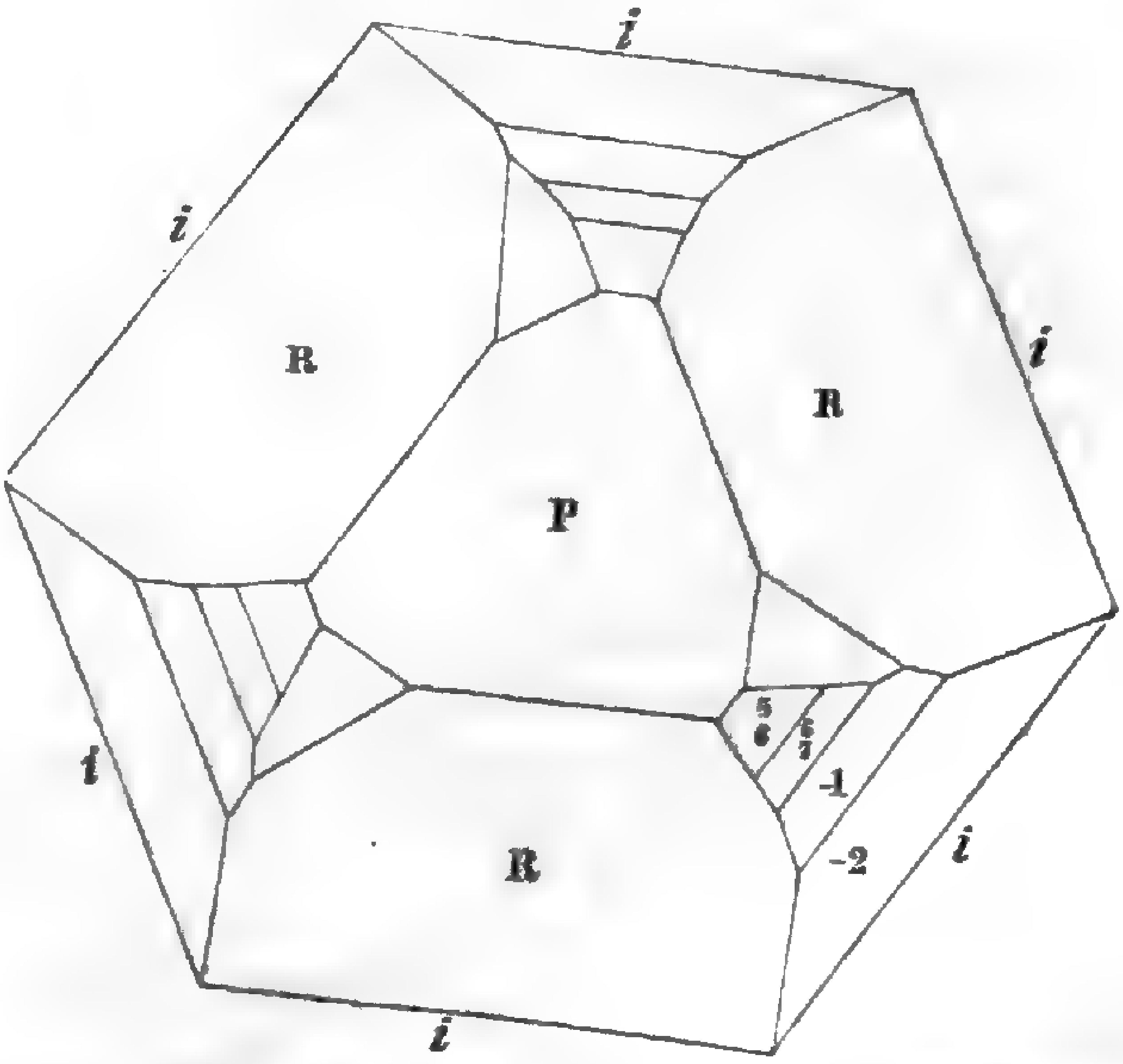

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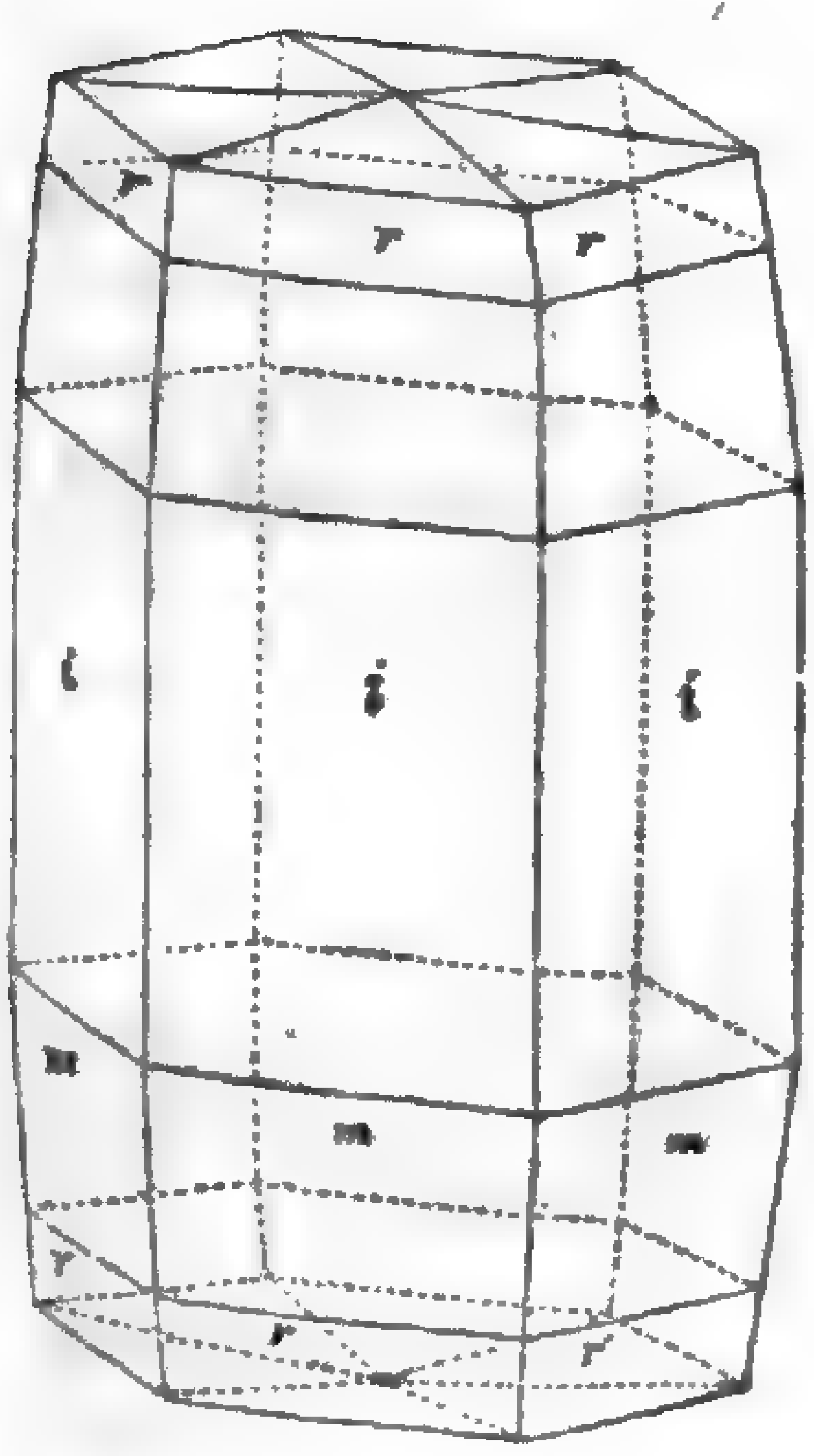

rov from different crystals are +R : —R=125° 38′, P (0R) : $\frac{5}{6}$R=118° 5′, $\frac{5}{6}$R : $\frac{5}{6}$R=80° 21′, P : $\frac{6}{7}$R=117° 25′, P : 2R=102° 32′. The vertical axis as stated is 1·94818, the lateral being 1.

Kokscharov reviews the angles of chlorite crystals as given by other observers. In a chlorite from Zillerthal, P : *m*R=104° 10′—104° 20′, G. Rose. $\frac{7}{4}$R gives for this angle 104° 15′. P(0R) : $\frac{3}{5}$R=126° 32′, near 126° 35′ an angle deduced from Descloiseaux's measurements of a Zillerthal crystal. Breithaupt gives the angle for the terminal edges of a rhombohedron 106° 16′ 15″; this gives 0R : *m*R=136° 9′ 17″; and *m*R therefore equals $\frac{3}{7}$R, which gives 0R : $\frac{3}{7}$R = 136° 2′ 50″. *Lophoite* of Breithaupt has the angle 0R : *m*R=105° 14′—105° 25′, and Descloiseaux calculating from the pyramidal angles 132° 40′ and 106° 40′, obtained 105° 33′. *m*R in this case equals $\frac{8}{5}$R, and 0R : $\frac{8}{5}$R =105° 32′.

Pennine according to Fröbel gives the angle 0R : *m*R=99° 0′; this corresponds to $\frac{14}{5}$R; 0R : $\frac{14}{5}$R=99° 1′ 16″. Descloiseaux makes this angle 100° 30′ 40″, which would correspond to $\frac{12}{5}$R; 0R : $\frac{12}{5}$R=100° 29′ 37″. $\frac{12}{5}$R : $\frac{12}{5}$R=63° 14$\frac{1}{2}$′.

Kämmererite of Nordenskiöld (Rhodochrome of G. Rose), afforded Kokscharov the angles, partly by calculation, P : $\frac{23}{5}$R=95° 31′; P : $\frac{32}{5}$R=93° 58′, $\frac{23}{5}$R : $\frac{23}{5}$R=60° 55′, $\frac{32}{5}$R : $\frac{32}{5}$R=60° 28′ 32″. The crystal figured (fig. 7) is a hexagonal prism, nearly barrel-shaped, owing to the planes $\frac{32}{5}$R and $\frac{23}{5}$R, which vary but little in direction from the prismatic planes. In another crystal P : $\frac{9}{7}$R=109° 4′ 22″ and $\frac{9}{7}$R : $\frac{9}{7}$R=70° 8′.

The Rhodonite or Fowlerite of New Jersey, in massive specimens of a reddish color, afforded Rammelsberg (J. f. pr. Chem., lv, 486):

	$\overline{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	$\dot{\text{Zn}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$
	46·70	31·20	8·35	5·10	6·30	2·81	0·28=100·74
Oxygen,	24·25	7·017	1·85	1·007	1·8	1·104	

On Humite; by C. Rammelsberg. This vol. p. 279.

Pyrosclerite.—The Pyrosclerite (or Kämmererite) of Texas, Lancaster Co., Pa., has been named *Rhodophyllite* by Dr. F. A. Genth, (Proc. Acad. Nat. Sci. Philad., 1852, 117). The mineral occurs in foliated masses, and sometimes in small hexagonal scales or crystals. H.=2·5. G.=2·617 (at 77° F). Color peach-blossom red, grayish and silver white; lustre pearly. Scales flexible, but not elastic. Analysis by Dr. Genth:

	$\overline{\overline{\text{Si}}}$	$\ddot{\bar{\text{Al}}}$	$\ddot{\bar{\text{Cr}}}$	$\ddot{\bar{\text{Fe}}}$	$\dot{\text{Ni}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Li}}$ $\dot{\text{Na}}$	$\dot{\text{K}}$	$\dot{\text{H}}$
	38·41		18·15		*trace*	35·86	*trace*	0·28	0·10	12·79=100·59
	32·98	11·11	6·85	1·43	——	35·22	——	0·28	0·10	13·12=101·09
Oxy.	17·12	5·19	2·12	0·32	——	14·08	——	0·11	0·02	11·66

Oxygen ratio, for the water, protoxyds, peroxyds and silica, equals 11·66 : 14·53 : 7·31 : 17·12=1·6 : 1·99 : 1 : 2·34. Fluorine and phosphoric or boracic acid could not be detected.

This mineral has been analyzed also by Mr. Garret; see this volume, page 332.

Delesse has examined (Bull. Geol. Soc., France, [2], ix, 122) a pyrosclerite (?) from the crystalline limestone of the Vosges (at St. Philippe).

It has a clear green color, to grayish green or bluish green, and sometimes emerald green; lustre greasy; hardness so slight that it has been considered a serpentine. G. =2·622. Attacked completely by boiling muriatic acid, without gelatinizing. BB. fuses with effervescence to a white blebby glass. Analysis gave:

$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{Al}}$	$\dddot{\mathrm{Cr}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$ (by diff.)	$\dot{\mathrm{H}}$
38·29	26·54	*trace*	0·59	*trace*	0·67	22·16	11·65=100

Pyrosclerite is often confounded with serpentine; its structure is usually more or less foliated, though sometimes fibrous.

On Pimelite.—W. Baer (J. f. pr. Chem. lv, 49) has analyzed one of two minerals called Pimelite by Karsten—the harder kind—and obtained, as the mean of two analyses:

	$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{Fe}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ni}}$	$\dot{\mathrm{H}}$
	35·80	2·69	23·04	14·66	2·78	21·03=100
Oxygen,	18·60	0·81	10·79	5·69	0·50	18·69

The oxygen ratio for the water, protoxyds, peroxyds and silica, is 18·69 : 6·28 : 11·60 : 18·60, whence M. Baer deduces the ratio 3 ; 1 : 2 : 3, and the formula $(\dot{\mathrm{Mg}}, \dot{\mathrm{Ni}})^3 \dddot{\mathrm{Si}} + 2 (\dddot{\mathrm{Al}}, \dddot{\mathrm{Fe}}) \dddot{\mathrm{Si}} + 9\dot{\mathrm{H}}$.

Specific gravity 2·71 to 2·76. Heated in a tube, blackens and yields water and a bituminous odor. BB. with soda gives a slag, and some nickel may be washed from the charcoal. H. 2·5; lustre waxy; feel greasy; translucent on the edges; does not adhere to the tongue. Dissolves in muriatic acid, even after heating.

The other pimelite of Karsten, called also *Chrysoprase Earth*, was analyzed by Klaproth (Beit. ii, 134).

A silesian mineral analyzed by C. Schmidt (Pogg. Ann. lxi, 388,) and called *Pimelite*, is a different species, and is called *Alizite* by Glocker. Its specific gravity is 1·44—1·46. Composition:

$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Ni}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{H}}$
54·63	32·66	5·89	1·13	0·16	0·30	5·23

affording the oxygen ratio 1 : 2 : 6, and the formula $2(\dot{\mathrm{Ni}}, \dot{\mathrm{Mg}}) \dddot{\mathrm{Si}} + \dot{\mathrm{H}}$.

Pipe-Clays from Nassau.—Fresenius, after separating the sand and hydrated silica from a clay from Nassau, gives the following for its composition, according to one of his analyses: Silica 55·40, Alumina 31·04, water 8·00; in another specimen he found 9·13 of water. Fresenius deduces the formula:

$$\dddot{\mathrm{Al}}\, \dddot{\mathrm{Si}}^3 + 2\dot{\mathrm{H}} = \dddot{\mathrm{Si}}\ 57{\cdot}14,\ \dddot{\mathrm{Al}}\ 31{\cdot}72,\ \dot{\mathrm{H}}\ 11{\cdot}14 = 100.$$

Hone-slate or Novaculite.—A very superior quality occurs on Carp River, Lake Superior Region (Foster & Whitney, loc. cit., p. 83).

Zeolites of Scotland.—The Pectolite found on the Isle of Skye at Storr, afforded Dr. A. J. Scott (Jameson's Edinb. New Phil. J., liii, 277):

$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
52·007	1·820	32·854	0·396	7·670	5·058=99·805

giving the oxygen ratio for the water, soda, lime, silica, 2 : 1 : 4 : 12, whence Dr. Scott deduces the formula,

$$\dot{\mathrm{Na}}\, \dddot{\mathrm{Si}} + \dot{\mathrm{Ca}}^4\, \dddot{\mathrm{Si}}^3 + 2\dot{\mathrm{H}} = \text{silica } 52{\cdot}6,\ \text{lime } 32{\cdot}4,\ \text{soda } 9{\cdot}1,\ \text{water } 5{\cdot}9.$$

It is in compact fibrous masses, of silky lustre, and is exceedingly tough. G.=2·784. BB. fuses to a bead without intumescence. Partially soluble in hydrochloric acid with the aid of heat, viscid flakes of silica separating.

Scolecite occurs in greenstone in long radiated needles, on the island of Mull. Composition according to Dr. Scott:

$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{Al}}$	lime	$\dot{\mathrm{H}}$
46·214	27·00	13·450	13·780=100·444

corresponding to the formula of Scolecite.

Natrolite is found at Bishoptown, Renfrewshire, in pure acicular crystals, 2 inches long, "interlaced into a felty mass," associated with mesolite in long radiated needles, and calc spar. Composition, according to Dr. Scott:

$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
47·626	27·170	15·124	9·780=99·700

The Laumonite of Storr in Skye, afforded Dr. Scott:

$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{H}}$
53·048	22·943	9·676	14·639=100·306

It is associated with stilbite. The same mineral from Snizort in Skye, has been analyzed by Connel.

Leonhardite of Copper Falls, Lake Superior Region.—Messrs. FOSTER and WHITNEY (loc. cit., p. 104) give the following analyses of a mineral which resembles Laumonite, but remains unaltered: they were made by Mr. G. O. Barnes, under the direction of Mr. Whitney:

$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{H}}$
55·96	21·04	10·49	11·93=99·42
55·04	22·34	10·64	11·93=99·95

Algerite.—After an examination of many specimens of this mineral in different cabinets, and especially a fine suite in the collection of Mr. Wm. S. Vaux, I am satisfied that the form of the crystals is a *square prism.* In external appearance, they would not be distinguished from scapolite, and this naturally suggests some relation to that species. —J. D. DANA.

Feldspar of the Granite of the Lake Superior Region.—Messrs. Foster and Whitney (loc. cit.) give the following results of an analysis of this orthoclase:—

	$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{Al}}$ & little $\dddot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
	66·70	18·68	0·30	9·57	3·58	0·70=99·53
Oxygen,	34·66	8·64	2.63			0·62

Unionite identical with oligoclase; J. LAWRENCE SMITH and G. J. BRUSH. This vol., p. 211.

On Petalite and Spodumene; C. RAMMELSBERG. This vol., p. 277.

Spodumene and *Petalite* are reviewed by R. HERMANN (ibid., p. 276) and various species referred to the same types. Spodumene, Acmite and Laumonite are considered as belonging to the *spodumene family*, and not to the pyroxene family, although so near it in crystallization.

In the application of heteromerism to spodumene, (J. f. pr. Ch., lvii, 276,) he supposes the two fundamental compounds (a)$=\dot{R}^3\dddot{Si}^2+\bar{R}\dddot{Si}^2$; (b)$=2\dot{R}^3\dddot{Si}^2+3\bar{R}\dddot{Si}^2$, and makes the varieties or species to consist of *a* and *b* either singly or in different proportions.

The *Petalite family* is made to consist of petalite, castor, heulandite, desmine (stilbite), edelforsite, neurolite and brewsterite. Petalite is described as monoclinic, like heulandite, the angle between one cleavage face (corresponding to M in fig. 1, heulandite, Dana's Min.) and another less distinct (plane ĕ of figure referred to) being 117° 30′, and a third in the same vertical series, 141° 30′. A plane in the same series observed by Breithaupt in his Castor (corresponding to T in the heulandite figure) makes with M the angle 129°.

Stilbite is recognized as monoclinic, Breithaupt having shown that the ordinary forms are compound crystals and related to heulandite.

Garnet.—A massive reddish translucent garnet from Haddam afforded Rammelsberg (J. f. pr. Chem., lv, 487)

	$\dddot{Si}$	$\bar{Al}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Ca}$	$\dot{Mg}$
	36·16	19·76	11·10	32·18	0·58	0·22
Oxygen,	18·79	9·23	2·46	7·21	0·16	0·09—G.=4·273

Allanite in Canada. Occurs sparingly in thin tables in a feldspathic rock on the mountain road from St. Joachim to Bay St. Paul, about two leagues before reaching the latter place (T. S. Hunt in Logan's Rep., cit., p. 120).

Orthite in Syenite near Dresden.—The similar associations of orthite at Dresden and Hitteroe are pointed out by E. F. Zschau in a paper in Leonh. u. Bronn's N. Jahrbuch, 1852, p. 652.

Mineral resembling Schorlomite.—C. Bergemann (Pogg. Ann. lxxxiv, 486) has analyzed a mineral from Brevig, resembling a little schorlomite but with the form of garnet. It occurs in large crystals with zircon, titanic iron, in feldspar. H.=5. G.=3·88, after heating 3·898. BB. infusible; with soda a yellowish glass; with borax, both when hot and cold, a yellowish green pearl. In hydrochloric acid dissolves easily before heating and with more difficulty after heating. Analysis:—

$\dddot{Si}$	$\dot{Fe}$	$\dot{Ca}$	$\dot{Mn}$	$\ddot{Ti}$, $\ddot{Zr}$
33·35	34·60	25·80	1·81	3·67 = 98·61

There is also a trace of magnesia and potash. Separating the titanic oxyd and part of the oxyd of iron as titanic iron, and the zirconia as zircon, the rest would have the composition of garnet, and Bergemann supposes that this may be the true nature of the mineral.

Mica.—Ettling on a new form of twin crystal of mica. (Ann. der Ch. u. Pharm., lxxxii, 337.)

Phlogopite.—A mica in the crystalline limestone of the Vosges, was found by Delesse (Bull. Soc. Geol., [2], ix, 121) to consist of—

	$\dddot{Si}$	$\bar{Al}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Na}$	$\dot{K}$	F	loss by ign.
	37·54	19·80	1·61	0·10	0·70	30·32	1·00	7·17	0·22	1·51=99·97
Oxygen,	19·51	9·25	0·37	0·02	0·20	11·73	0·26	1·22		

It is remarkable for the large proportion of magnesia. Formula $3\dot{R}^3\dddot{Si}+\dddot{\bar{R}}^2\dddot{Si}$. Delesse observes that phlogopite occurs in granular limestones, especially the dolomitic, in France as well as in America.

On Emerylite, Euphyllite, Margarite, Mica; by J. Lawrence Smith and G. J. Brush.—This volume, p. 207.

Emerylite.—G. Rose (Kryst.-Chem. Min., 1852, p. 40) makes emerylite identical with diphanite, under the formula $2(\dot{Ca},\dot{Fe})^2\dddot{Si}+3\dddot{\bar{Al}}^2\dddot{Si}+4\dot{H}$. [The analyses of margarite by Hermann and also by Dr. J. Lawrence Smith and G. J. Brush, prove its identity with margarite. See this volume, pp. 46 and 208.]

Tourmaline.—C. F. Naumann has reviewed the published analyses of tourmaline, (J. f. pr. Chem., lvi, 385,) and after showing that the oxygen ratio for the protoxyds and peroxyds among 29 varieties analyzed by Rammelsberg, varies from 1 : 3 to 1 : 16; he adopts Hermann's view of Heteromerism, in explaining the composition.

Lapis Lazuli in the Cordilleras of the Andes.—Mr. F. Field mentions (Quart. J. Chem. Soc., iv, 331) the occurrence of large masses of a bright blue rock in the Cordilleras, which proved on analysis to be Lapis Lazuli, interspersed with small veins of pure carbonate of lime. The particular locality is not mentioned. It afforded on analysis:—

$\dddot{Si}$	$\dddot{\bar{Al}}$	S	Fe	$\dot{Mg}$	$\dot{Na}$	$\ddot{C}$	$\dot{Ca}$
37·60	11·21	1·65	0·08	0·36	9·66	15·05	24·10=99·71

On Tourmaline and Epidote; R. Hermann. (Jour. f. pr. Chem., lv, 451.)

Euclase.—An analysis by J. W. Mallet, (Phil. Mag. [4], v, 127,) afforded—

$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dddot{\bar{Be}}$	$\dddot{\bar{Fe}}$	$\dot{Sn}$
44·18	31·87	21·43	1·31	0·35=99·14

The formula deduced by Mr. Mallet is $\dddot{\bar{Be}}^2\dddot{Si}+2\dddot{\bar{Al}}\dddot{Si}$, or if alumina and glucina are isomorphous, $(\dddot{\bar{Be}},\dddot{\bar{Al}})^4\dddot{Si}^3$. Specific gravity, 3·036.

Analysis of *Beryl* from granite of Hirschgasse near Heidelberg, by M. Borntrager; and a *Beryl* from Zwiesel in Bavaria, by W. Mayer, (Jahrb. Min. 1851, 185; Lieb. and K.'s Jahersb. f. 1851, 779.)—

$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dddot{\bar{Fe}}$	$\dot{Be}$	$\dot{Mn}$
66·90	18·15	2·95	12·20	—— =100·20
66·56	17·82	2·43	12·66	0·11 = 99·58

Orangite.—Analysis by Damour, (Ann. des Mines, [5], i, 587.)—

$\dddot{Si}$	$\dot{Th}$	$\dot{Ca}$	$\dot{Pb}$	$\dddot{\bar{U}}$	$\dddot{\bar{Mn}}$	$\dddot{\bar{Fe}}$	$\dddot{\bar{Al}}$	$\dot{K}$	$\dot{Na}$	$\dot{H}$	$\dot{Mg}$
17·52	71·65	1·59	0·88	1·13	0·28	0·31	0·17	0·14	0·33	6·14	*trace*

The formula $\dot{Th}^3\dddot{Si}+2\dot{H}$, is that of *Thorite*, with which the species is identical.

On the Sphene of Grenville, Canada; by T. S. Hunt, (Logan's Rep., loc. cit., p. 118.)—This sphene, named Lederite by Shepard, occurs in crystals and masses in a vein of plumbago, with tabular spar, feldspar, pyroxene, idocrase and rarely zircon and cinnamon-colored garnet. H. =5·5. G. =3·49–3·499, from one locality; 3·510, from another. Color light clove-brown or chocolate brown; translucent. The following analysis shows it to be identical with common sphene.

$\ddot{\mathrm{T}}\mathrm{i}$ and trace of iron.	$\dddot{\mathrm{S}}\mathrm{i}$	$\dot{\mathrm{C}}\mathrm{a}$	Loss by ign.
40·00	31·83	28·31	0·40=100·54

At Montreal, Yamaska, Monnoir and Brome mountains. The crystals are imbedded in feldspar, minute, of an amber or honey-yellow color, transparent, brilliant, and highly modified.

Schorlomite.—Rammelsberg has revised his analyses of this mineral and states that the formula of J. D. Whitney is the correct one.* Rammelsberg writes it $2\dot{\bar{\mathrm{R}}}^3\dddot{\mathrm{S}}\mathrm{i}+\dddot{\bar{\mathrm{F}}}\mathrm{e}\ddot{\mathrm{T}}\mathrm{i}^2$. He obtained, (J. f. pr. Ch., lv, 488,)

	$\dddot{\mathrm{S}}\mathrm{i}$	$\ddot{\mathrm{T}}\mathrm{i}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{M}}\mathrm{g}$
	25·24	22·34	20·11	1·57	29·38	1·36
Oxygen,	13·11	8·87	6·03	0·35	8·36	0·54

On Molybdenite from near Reading, Pa.; by C. M. Wetherill, (Trans. Amer. Phil. Soc., x, 345.)—The molybdenite occurs in plates and scales in quartz. G. =4·52. BB. on charcoal, white fumes coating the coal; alone in a tube, fumes of sulphurous acid. In the platinum forceps, colored the outer flame yellowish green. Analysis gave Dr. Wetherill:—

S	Mo	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dddot{\mathrm{S}}\mathrm{i}$	$\dot{\mathrm{H}}$
38·198	55·727	3·495	2·283	0·297

affording, if the impurities are excluded, Sulphur 40·668, molybdenum 59·332=100.

On Zircon from near Reading, Pa.; by C. M. Wetherill, (Trans. Amer. Phil. Soc., x, 346.)—The zircon occurs in large crystals imbedded in magnetic iron ore; the largest mentioned measured 1½ by 1¼ by ⅜ in. nearly. Color chocolate brown; opaque; lustre adamantine. Surface uneven and edges rounded as if subjected to an incipient fusion. G. = 4·595. Composition, Silica 34·07, zirconia 63·50, peroxyd of iron 2·02, water 0·50=100·09.

Berthierite.—This mineral has been announced by M. A. Daubrée, (Ann. des Mines, [5], i, 123,) as occurring in the Vosges in the Commune of Lalaye (Lower Rhine) in antimony veins traversing transition schists. It is a steel-gray mineral not lamellated like the sulphuret of antimony in which it occurs. It becomes magnetic on calcination. The proportion of antimony to iron in the ore is about 32 to 18. The antimony veins of the regions are from a meter to a meter and a half in width, but unfortunately they have little horizontal extent, being lost in ramifications, or abruptly disappearing.

Native Metallic Iron.—Dr. Andrews in an examination into the minute structure of basalt, has found evidence of the existence of iron in a native state. After pulverizing the rock and separating with a magnet the grains that were attracted by it, he subjected these grains, which were mostly magnetic iron, to the action of an acid solution of sulphate of copper in the field of a microscope. This salt produces no change with the oxyd, but if a trace of pure iron be present,

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* The analyses in Dana's Mineralogy, 3d edit., p. 394, should properly be credited to J. D. Whitney.—J. D. D.

copper is deposited. In his trials, there were occasional deposits of copper in crystalline bunches; the largest of which obtained was little more than one-fiftieth of an inch in diameter. He observes that with 100 grains of the rock, 3 or 4 deposits of copper can usually be obtained. The basalt of the Giant's Causeway affords this evidence of the presence of native iron, but less so, than the Slievemish basalt.

The same result would be produced, if the nickel or cobalt were present in fine grains; but Dr. Andrews considers this very improbable. The same basalt afforded, on microscopic examination, augite, magnetic iron, pyrites and a colorless glassy mineral.

The metamorphic rock of Portrush—an indurated clay of the Lias, somewhat resembling Lydian stone in external appearance—under a microscope is everywhere thickly studded with perfect cubes of *pyrites*, 20 of which could often be counted in the space of 1-100th of an inch square; they measured each way about 1-2000th of an inch. With a magnet, minute particles or crystals of magnetic iron were found in the same rock.

On Nickeliferous iron pyrites, from Kearney Ore Bed, Gouverneur, St. Lawrence Co., N. Y.; by Prof. C. U. SHEPARD, (Proc. Amer. Assoc., vi, (Albany meeting,) p. 230.)—This mineral occurs in botryoidal concretions, somewhat radiated structure and pale bronze color, at the same place with Millerite. H. =5·5. G. =4·863. The presence of nickel was ascertained, but not the proportion.

Limonite containing Vanadium.—A limonite (bohnerz) from Staatswald Hardt, Württemberg, contains according to Dr. A. Müller (J. f. pr. Chem., lvii, 124) about 0·05 p. c. of chromic acid and not over 0·03 p. c. of vanadic acid.

On the Iron Ores of the Lake Superior Region, etc.—Messrs. FOSTER and WHITNEY's Report on the Lake Superior Land District, Part II, 1851, p. 50–77. Ores with a metallic lustre and appearance of purity from the Jackson's Company location afforded

	1. Massive.	2. Slaty.
Oxygen,	29·46	29·09
Iron,	68·07	69·09
Insoluble,	2·89=100·42	1·64=99·82

It is a mixture of the peroxyd and magnetic oxyd. A fine grained ore, from the Marquette Company's ore bed afforded iron 70·22, oxygen 29·53, insoluble 0·20=99·95; corresponding to peroxyd of iron 90·58, magnetic oxyd 9·17, silica 0·20. Some of the ores are pure peroxyds, but many are mixtures of the two oxyds.

Iron ores in the Des Moines Coal Fields.—Dr. D. D. OWEN has detected phosphoric acid in the carbonates of iron of Des Moines, and attributes it to the microscopic Lingulas which occur in it. (Proc. Amer. Assoc., v, [Cincinnati meeting,] 47.)

On Manganese ore from India; by Dr. A. J. SCOTT, (Jameson's Edinb. New Phil. J., 1852, liii, 277.)—The ore from Vizianagram is bluish black. G.=4·50. Breaks with difficulty; powder dark brownish black. Composition—

$\dddot{\mathrm{Si}}$	$\dddot{\cancel{\mathrm{Fe}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$	Red ox. of Mn	O
8·300	12·910	2·339	0·539	73·786	1·864=99·735

The oxyd of manganese corresponds nearly to the sesquioxyd, the percentage being manganese 70·63, oxygen 29·37.

Another ore from Bimlapatam, afforded, besides impurities, red oxyd of manganese 76·117, oxygen 0·655, which is a little less oxygen than is required to make it a sesquioxyd.

Franklinite of New Jersey.—Mr. A. C. Farrington, (Proc. Amer. Assoc., vi, 241) has observed the interesting fact, that the Franklinite of the large vein is strongly magnetic where it adjoins the igneous rock enclosing it, (being taken up by a magnet when pulverized) but gradually diminishes in its magnetism on receding from the walls of syenite, it being perceptible only for four feet. Mr. Farrington inferred that the metal near the walls was protoxyd mainly and peroxyd remote from them, and a mixture in other parts.

Triphyline of Bodenmais.—Rammelsberg has analyzed this mineral (Pogg. Ann., lxxxv, 439) with the following result.

	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{M}}\mathrm{n}$	$\dot{\mathrm{L}}\mathrm{i}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$	$\bar{\mathrm{Si}}$
Analysis I,	39·35	41·42	9·43	7·08	1·07	0·35	1·28	—— = 99·98
Mean of four anal.,	40·72	39·97	9·80	7·28	1·45	0·58	——	0·25=100·05
Oxygen,	22·82	8·87	2·19	4·00	0·37	0·10		

Formula for the mean result, $3\dot{\mathrm{R}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+2\dot{\mathrm{R}}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$; for the first analysis which gives the oxygen ratio 10 : 7, $\dot{\mathrm{R}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\dot{\mathrm{R}}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$.

The triphyline on alteration, loses its alkali, takes up water and oxygen, the iron and manganese becoming peroxyds. The mineral from Norwich, Mass., and Damour's *Alluaudite* are of this kind. The *Triplite* of Limoges, according to Berzelius, has the formula $\dot{\mathrm{R}}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$.

The *Heterosite* of Limoges, or a brownish violet mineral from this locality, afforded Rammelsberg,

$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dddot{\bar{\mathrm{M}}}$	$\dot{\mathrm{H}}$
32·18	31·46	30·01	6·35

giving the formula $\dddot{\bar{\mathrm{R}}}^7\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}^4+6\dot{\mathrm{H}}$. But reckoning it as a protoxyd compound, the formula becomes, excluding the water, $\dot{\mathrm{R}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\dot{\mathrm{R}}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$.

Triplite of Norwich, Mass.—The crystals of this mineral are referred by Shepard (Proc. Am. Assoc., vi, 234) to the monoclinic system, and the following angles taken by the reflective goniometer are given; a rhombic prism, of 130° 45′ to 131° 15′; another exterior, inclined to the preceding, 167°; angle M : T ($0P : \infty P \infty$) 96°; a clinodiagonal prism making with 0P the angle 108°.

[Prof. Shepard alludes to the fact that J. D. Dana mentions the obliquity of certain of the crystals, as an irregularity, and he regards the above view as removing this irregularity. This mode of viewing them does correspond with the oblique crystals observed. But the irregularity is still a fact, for many of the crystals, (we speak from observation) have the angle M : T, 90°, and these crystals include the smaller ones, which are most likely to give the normal form. There is therefore better evidence, that the crystals are right than oblique; and we believe from our observations that the right prism is also the more prevalent form. There is some doubt as to some of Prof. Shepard's angles. The angle P : M ($0P : \infty P' \infty$) is given at 90°, while P and M make with a plane on the edge intermediate, 108° and 140° 15′; the sum of which angles, *if correct*, would be 270°. The angle between P and

D [$\infty P' \infty$ and ∞P] is stated at 119°; while the angles made by *P* and D with the plane *x*, on the intermediate edge, are given at 138° 45′ and 167°; the sum of which *should* equal 299° (119°+180°).]

Galena.—Galena of the Upper Mississippi, D. D. OWEN, Rep. Geol. Survey of Wisconsin, Iowa and Minnesota, p. 60.

White Lead ore of Teesdale, in Durham.—Analysis by J. A. PHILLIPS (Quart. J. Chem. Soc., iv, 175); oxyd of lead 83·56, carbonic acid 16·05=99.61.

On Leadhillite in Newberry District, S. C.; by C. U. SHEPARD, (Proc. Am. Assoc., vi, 231.)—Occurs in apparently regular hexagonal prisms, and 6-sided very acute pyramids. Color pale greenish or yellowish white.

*Matlockite.**—RAMMELSBERG has analyzed this ore (Pogg., lxxxv, 141) and deduces the formula, $PbCl + PbO$, corresponding to 55·62 $PbCl$, 44·38 PbO.

Molybdate of Lead.—This ore from Wheatley's Mine, near Phenixville, Chester Co. Pa., has been examined by C. M. WETHERILL (Proc. Acad. Nat. Sci. Philad., 1852, 55 and 119) without detecting any chromium. The color of the crystals is light red.

Native Copper of the Lake Superior region.—FOSTER and WHITNEY observe that the crystals from this region are usually tetrahexahedrous, formed by a bevelment of the edges of a cube. The largest mentioned was one-fourth of an inch in diameter (loc. cit., p. 99).

Crystals of analcime occur at Copper Falls which are penetrated throughout with delicate ramifications of metallic copper, so that if the analcime should be dissolved away, the form of the crystal would still remain in the copper.—*Ib.*

On a Copper ore from between the Mississippi and Kickapoo; by Dr. D. D. OWEN (Rep. Geol. Survey of Wisconsin, Iowa and Minnesota, 4to, 1852, p. 53).—This ore is an impure one, resembling chrysocolla, in appearance being of a light green color, waxy lustre and fracture, and very brittle. Analysis of a specimen of average quality, afforded, protoxyd of copper 25·0 (corresponding to 19·87 of copper), peroxyd of iron 48·7, protoxyd of manganese 0·2, insoluble silicates with a trace of oxyd of iron 8·3, alumina 0·6, carbonate of lime 0·8, carbonic acid 5·0, water 11·2=99·98.

Copper ore, containing Gold.—This ore, described by Mr. F. FIELD, (Quart. J. Chem. Soc., iv, 332,) is soft, of greasy appearance, an intense greenish gray color, somewhat inclining to red, powder bright red. It is from the mine *Altar*, about 30 leagues from Coquimbo, and is associated with pyrites, blende, galena, and copper pyrites. Composition:

S	As	Sb	Cu	Zn	Fe	Ag	Au
30·350	3·912	20·284	36·720	7·260	1·232	0·075	0·003

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* In this Journal, xii, 388, from Phil. Mag., [4], ii, 120.

According to M. Domeyko, the ore consists of a mixture of galena, iron pyrites, blende and gray copper, in amorphous quartz as the matrix.

Chrysocolla.—Rammelsberg found in a chrysocolla (J. f. pr. Chem., lv, 488)

	$\dddot{Si}$	$\dot{Cu}$	$\dot{Fe}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{H}$
	32·55	42·32	1·63*	1·76	1·06	20·68
Oxygen,	16·91	8·53	——	0·50	0·42	18·31

Formula, $\dot{Cu}^3 \dddot{Si}^2+6\dot{H}$.

Copper ores of Adelaide, Australia.—The following ores are reported as coming from different mines near Adelaide. Red Copper ore, Azurite, Malachite, Chrysocolla, Atacamite, with specular iron, Galena and native Bismuth. The last is accompanied with Bismuth ochre and Iron ochre in a red flinty rock.—A. L. Sack, in Jahresb. nat. Ver. Halle, 1851, 57.

Arsenical Nickel.—An ore from Allemont afforded Rammelsberg (J. f. pr. Chem., lv, 486):

S	As	Ni	Fe
2·29	71·11	18·71	6·82—G=6·411

Chloro-bromid of Silver from Chili.—This ore afforded Domeyko (Elementos de Mineralogia, 1845, 203), in three trials:

Chlorid of Silver, .	51·0	52·8	51·0
Bromid of Silver, .	49·0	47·2	49·0

His specimens were from Chañarcillo; they were at times crystallized in shining cubes and cubo-octahedrons, having an asparagus or pistachio green color. G. =5·31—5·43. The formula deduced is Ag Cl+Ag Br. Other varieties of a grayish green color, varied much, affording of the chlorid, 72·9, 65·6, 81·4, 66·4 per cent. The last was from Quillota, the others from Chañarcillo.

Mr. P. Yorke has recently analyzed similar crystals (Quart. J. Chem. Soc., iv, 2) from Chili, and obtained, Chlorid of Silver 53·2, Bromid of Silver 46·8. Whence he has the formula 3Ag Cl+2Ag Br=Ag Cl 53·7, Ag Br 46·3. Specific gravity 5·53.

Cinnabar.—J. Schabus has investigated the crystals of this mineral, and obtained for the fundamental rhombohedron, 92° 37′ 6″, the inclination of the faces on the terminal plane (0R) being 127° 5′ 45″. The angle of the rhombohedron —2R is 71° 47′ 10″; $-\frac{2}{3}R=110° 7' 44''$; $-\frac{4}{5}R=101° 56' 30''$.

Cinnabar of California; by A. Bealey.—Specimens of this cinnabar afforded the specific gravity 4·410, and the composition:

Quicksilver, . .	69·36	70·13	69·90
Sulphur, . .	11·38	11·26	11·29
Iron, . . .	1·23	——	1·23
Lime, . . .	1·40	——	1·40
Alumina, . .	0·61	——	0·61
Magnesia, . .	0·49	——	0·49
Silica, . . .	14·30	14·52	14·41

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* Peroxyd of iron and alumina.

The Almaden ore affords quicksilver 37·79, sulphur 16·22, iron 10·36, silica and alumina 35·12. The ore of Moschellandsberg, gives quicksilver 66·86, sulphur 11·43, insoluble residue 17·09; and that of Wolfstein, 18·00 p. c. of quicksilver.

Crystal of Native Gold.—Prof. C. U. SHEPARD describes (Proc. Amer. Assoc., vi, 231) a crystal measuring $\frac{3}{5}$ths of an inch across, weight 121·1 grains. Form the pentagonal dodecahedron. The edges are raised, as in many other California crystals of this metal.

Gold in Pennsylvania.—Dr. C. M. WETHERILL mentions (Trans. Amer. Phil. Soc., x, 350) the occurrence of gold in the earth obtained on digging a well; the exact place is not certain, but it was probably in Franconia township, Montgomery Co. Several rocks of the neighborhood on trial proved to contain gold in traces along with pyrites and magnetic iron. In the earth from the well, along with the spangle of gold, a white malleable particle of metal was found which gave the reactions of native *tin*. Judging from the amount of gold obtained, one hundred pounds of the earth would afford 0·4 grammes of gold, worth about 26½ cents.

Gold of Canada.—Specific gravity of worn fragments of gold from the R. du Loup, 15·761, 16·490, 16·654, 17·60, 17·77. The third specimen after being hammered to a thin plate, and twice annealed, had the sp. gr. 17·024; and the fifth after the same process, 17·848. These two afforded, (I) gold 86·40, silver 13·60, (II) gold 87·77, silver 12·23. A third in fine scales, gave gold 89·24, silver 10·76; G. = 16·57.

Gold in Vermont.—This volume, p. 174.

Iridosmine and Platinum of California,—associated with a probably new element; Dr. F. A. GENTH, (Proc. Acad. Nat. Sci. Philad., 1852, 209,) this volume, p. 246.

Platinum and Iridosmine in Canada.—The gold washings of the Rivière du Loup and R. des Plantes, afford grains of Platinum; there are also tin-white grains, generally hexagonal in form, which prove to be Iridosmine. (T. S. HUNT in Logan's Rep., cit., p. 120.)

On the Crystallization of Chondrodite; by J. D. DANA.—The chemical identity of Humite and Chondrodite is well known, but the crystallography of the two has not been shown to be accordant. The writer has given in his Mineralogy (2d edit., p. 388, and 3d edit. p. 280), and in this Journal, vol. xlvi, fig. 6, p. 381 (1846), the only *figure* of a crystal of chondrodite yet published. It represents an acute oblique rhombic prism, terminating in large pyramidal planes, lettered ē and ĕ, and having also the planes of a clinodiagonal prism (*a*); M : M (over side edge) = 112°, M : ē = 157°, M : ĕ = 136°; ē : ĕ (in the same pyramid over clinodiagonal edge, or plane *a*) = 127°, *a* : *a* over the summit 85°. The surfaces were not quite smooth and the angles were given as approximations only.

We can now exhibit the resemblance to Scacchi's figures of Humite, in Pogg. Ann., 1851, Ergänz., ii, 161, and this Jour. [2], xiv, 175. The hemihedral form of humite is represented evidently in the chondrodite. Consequently the planes M and M are planes of an orthodiagonal prism.

See for comparison Scacchi's figures, and p. 181, of volume xiv, of this Journal. The most common plane of the orthodiagonal series in Humite, and the only one occurring in all the types, is our $\frac{1}{2}\bar{i}$ or $\frac{1}{2}\cdot\breve{\infty}$, (in Scacchi's figures, *i*2 of Type I and III, and *i* of Type II); and the front angle of this prism, taking the mean of the three types, is 112° 2′ (111° 28′ for Type I, 115° 6′ for II, 109° 31′ for III); and this is actually the *angle M : M of chondrodite.*

Again, M : ĕ = 136°. Now $\frac{1}{2}\bar{i}$ ($\frac{1}{2}\text{-}\bar{\infty}$) in Type III, makes an angle with $\frac{4}{3}\cdot\breve{2}$ (Scacchi's n^3)* of 134° 23′. Again, M : ē = 157°, and this is very nearly the angle of $\frac{1}{2}\bar{i}$ ($\frac{1}{2}\text{-}\bar{\infty}$) on $\frac{4}{9}$ or $\frac{4}{7}$ (r^4 or r^5 of Scacchi). But the inclination of ē : ĕ over *a* is 127°; and this equals nearly the angle between $\frac{4}{3}\text{-}\breve{2}$($n^3$) and $\frac{4}{7}$(r^5), one above and the other below the plane of the lateral axes, this angle being according to our calculation 126° 52′. Considering the dissimilarity of the three types in Humite and the unevenness of the surfaces measured, the coincidences are as close as could be expected.

Again, the prism *a* has the angle 85°; and calculation gives for the corresponding angle of $\infty\cdot\breve{2}$ in humite (a plane not given by Scacchi but between his *o* and *o*2), 85° 34′. There is also another plane (ă) in the figure of chondrodite which is probably the brachydiagonal prism $4\cdot\breve{\infty}$, judging from the inclination of this plane on the edge between ĕ and é, which according to the writer's observation was 168°.†

Note on Tabular Spar or Wollastonite; by J. D. Dana.—In the usual mode of viewing the crystals of this species, the relation to Pyroxene which exists is not shown. But making the clinodiagonal the vertical axis, there is then a vertical prism of 87° 28′ (*e*, *e*′, in Brooke and Miller's figure), varying but 23 minutes from that of pyroxene. The inclination of the axes is 69° 48′. The vertical axis in tabular spar is about one-fifth shorter than in ordinary Pyroxene, and this is the main point of distinction in the form of the crystals.

2. *Notice of a crystal of Fischerite;* by Nicholas Kokscharov, (communicated for this Journal.)—The Fischerite occurs in small translucent crystalline plates and crystals in the fissures of a ferruginous sandstone, near Nischne-Tagilsk in the Urals. Stschourowsky considered the crystals of this mineral to be hexagonal prisms; but the measurements which I have made show that they are rhombic prisms and not hexagonal. The acute edges of the prism are either truncated or beveled, and the crystals terminate in a flat summit plane. By means of the reflective goniometer I have measured the angles of two different rhombic prisms, obtaining for one, 118° 32′ (*mean of 5 trials*) and for the other 99° 56′ (mean of 3 trials). The first measurements should have the preference; and taking the prism as the prism of the fundamental series, we have, for the vertical (*a*) and lateral axes (*b*, *c*) the ratio $a : b : c = x : 1{\cdot}68196 : 1$
also the prism $\infty P = 118° 32′$ and 61° 28′, and the prism $\infty P\breve{2} = 99° 52\frac{1}{2}′$ and 80° $7\frac{1}{2}′$; $\infty P : \infty P\breve{\infty} = 120° 44′$, $\infty P\breve{2} : \infty P\breve{\infty} = 139° 56\frac{1}{4}′$.

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* In our copies of Scacchi's figures, his planes *r*, are made of the general form *mP*, his planes *n*, of the form *mP*2, and his *ms* of the form *mP*3. In giving the crystallographic symbols above we omit the *P*.

† In the analyses of humite, p. 279, Fe, should be Fl.

3. *On Argentiferous Galena from Arkansas;* by Prof. W. W. Mather, (communicated for this Journal).—Some of this ore from a locality not communicated, was lately sent me for cupellation. Different specimens afforded silver, varying from 44 to 71 ounces of silver to the ton of lead. I have cupelled hundreds of lead ores, and although I have never cupelled one without finding a trace of silver, there are few as rich as the one above mentioned.

4. *On the alleged great Coal Bed of Perry County;* by Professor W. W. Mather, (communicated for this Journal.)—Mention has been made in your Journal, and in the papers, about the coal bed said to be more than 100 feet thick, and some have quoted me as authority for such statements. I had never seen it, neither had any one on the Geological survey of Ohio seen or described it, till last autumn, when I was called to examine it professionally. The slides of coal on the hill side, and a thin seam of coal in place in the bed of the small stream below, and the thick seam of coal 12 to 17 feet thick near the top of the hill, are the obvious causes of the great mistake in the thickness of this coal bed. Persons not acquainted with modes of examination, and the liability of deception, seeing the coal in the hill and along the slope of the hill, where slides had occurred but were not recognized, and coal in place in the Run, inferred that the whole hill from the upper to the lower beds was a solid mass of coal. Although we have heavy beds of caking coals, dry burning bituminous coals, and cannel coals of superior qualities in inexhaustible abundance, I have seen no coal bed in Ohio exceeding 17 feet in thickness. Many of the hills however, contain several different seams of coal, and sometimes two or three of them are workable. Iron ore and limestone are associated with the coal in the same hills, and in some instances, coal, limestone and iron ore form contiguous beds with no intervening materials, and of workable thickness. The iron region of Ohio is now being intersected by numerous railroads, furnaces are in operation, and others are building, and the time is not very far distant when that district will be what South Wales now is, and coke or the raw dry burning coals will be the only fuel used for smelting. The iron ores are so abundant that the lands on an average will yield 5,000 to 10,000 tons of iron per acre.

5. *On the supposed bed of Coral at a high elevation, on the Island of Maui;* by Dr. C. F. Winslow, (from a letter to J. D. Dana, dated Waltham, Mass., March 13, 1853.)—In your paper on Changes of Level in the Pacific Ocean, published in the March No. of the Am. Journ., at pages 171 and 172, I notice the account given you by my friend, Rev. Mr. Andrews of Molokai, of the existence of coral formations on the elevated parts of West Maui. In reference to the account as evidence of the modern elevation of Maui many hundred feet above the ocean, you observe that it should be received with great hesitation, until further examined. In this you are right. I have been over the regions many times, and examined them with some care. My first impression, like that of Mr. Andrews, on simply looking at the rock, was that it was calcareous. I took specimens with me for chemical experiment, to decide the question of its organic origin. Sulphuric acid exhibited no observable reaction nor disengagement of gases, and I consequently doubted its calcareous character. Afterwards, in conversation with

Rev. Mr. Alexander, (a very acute and highly informed gentleman who is the Principal of the Lahainaluna Seminary,) on the nature and origin of this rock, he informed me that his first opinions were similar to my own, and that he had submitted it to sufficient examination to convince him that there was *no lime* in its composition. This belt of rock is about 400 or 500 feet of perpendicular elevation above his residence, and about 1200 feet above the sea.

From the evidence in my possession on that point, I think you may assume, without fear of contradiction, that no coral formation exists on the very elevated side of West Maui.

IV. BOTANY.

1. *Principles of the Anatomy and Physiology of the Vegetable Cell;* by HUGO VON MOHL, M.D., etc., Prof. Bot. Univ. Tubingen, etc. etc. Translated (with the author's permission) by Arthur Henfrey, F.R.S., etc. With an illustrative plate and numerous wood-cuts. London: Van Voorst, 1852, pp. 158, 8vo.—We desire in a special manner to commend this condensed treatise not only to botanists, but to animal physiologists, to medical students, and to all who would obtain a clear view of the present state of vegetable anatomy and physiology,—a knowledge of which, most interesting in itself, is almost indispensable to the correct understanding of the minute anatomy and physiology of animals. Prof. Mohl is, without question, the first of vegetable anatomists, and his statements carry with them the highest authority on this class of subjects. We copy the short preface which he has contributed to the English translation, as it gives a clear view of the nature and scope of the work.

"Mr. Arthur Henfrey having informed me that he intends publishing an English translation of the present treatise, I take this opportunity of making known to the English reader the purpose I had in view in the preparation of the book. The following pages were not originally intended to appear as an independent work, or to give a summary of the wide subject of the Anatomy and Physiology of Plants, but appeared as an article, in the 'Cyclopedia of Physiology,' published by Dr. Rudolph Wagner, of Göttingen, drawn up to furnish students of Animal Physiology, and more particularly the medical profession, with a review of the anatomical and physiological conditions of vegetables (of the cell), in order to enable them to form a definite judgment upon the analogies which might be drawn between the structure and vital functions of animals and plants. This intention, together with the circumstance that I was compelled to crowd the whole exposition into the space of a few sheets, rendered it necessary to direct especial attention to the individual cell, as the fundamental organ of the vegetable organism. Since, however, the cell only presents itself in anatomical and physiological independence in the lowest plants, and since, in the more highly organized plants, both the structure and the physiological functions of the individual cells become subject to greater dependence upon the other parts of the plant, in proportion as the collective organization of the vegetable is more complex; moreover, since functions then present themselves, of which no trace can be found in the lower plants, it became requisite to take account of the plants of higher rank, and of the various organs which these possess. The treatise, therefore, contains, if an imperfect, still in many respects, a more extensive resumé of Vegetable Physiology, than might be conjectured from the title.

"Unhappily, the Physiology of Plants is a science which yet lies in its earliest infancy. Few of its dogmas can be regarded as settled beyond doubt; at every step we meet with imperfect observations, and consequently with the most contradictory views; thus, for example, opinions are still quite divided regarding the doctrines of the development of the cell, of the origin of the embryo, and of the existence of an impregnation in the higher Cryptogams. Both in these and in other cases, the small compass of the present treatise forbids a more extensive detail of the researches upon which the opposing views are founded; I hope, however, that I have succeeded in making clearly prominent the chief points upon which these contests turn, and thus in facilitating the formation of a judgment by the reader; and I have never neglected to indicate the literature from which further instruction is to be derived."

It may be well to notice the views of so excellent an observer upon sundry points which have been more or less matters of controversy. As to the milk-vessels, or vessels of the latex, Mohl inclines to adopt the view that considers them as intercellular passages which have acquired membranous linings. (p. 2.) He denies that the membrane of nascent cells is soluble in water, as Schleiden states. (p. 9.) He briefly states the grounds on which, in his controversy with Harting and Mulder, he successfully maintains that the primary cell-membrane is thickened by successive concentric layers of cellulose deposited on its inner face. The combination of spiral markings and pits on the wood-cells of Taxus and Torreya, as also in the Linden, is explained by considering the former to belong to a second layer or deposition, within that to which the pits belong. This tertiary membrane or deposit forms the spiral fibre or band in the cells of the seed-coat of Collomia, the hairs of the achenium of Senecio, &c. (p. 18.) The whole subject of spiral and other markings, rings, dots, slits, reticulations, &c. on the walls of cells is expounded in a masterly and convincing way. Mohl maintains, (p. 28), as he had done in the *Botanische Zeitung*, that cellulose forms the basis of all vegetable membranes in the higher plants, and that what Mulder regarded as peculiar compounds are combinations of cellulose with foreign infiltrated deposits, which interfere with the chemical reactions of cellulose, but which may be removed by previous maceration in caustic potash and nitric acid. He now maintains, in opposition to his early view (still defended by Schleiden) that the *intercellular substance* is a product or secretion of the cell, and not an universally distributed mass in which the cells are imbedded. (p. 33.) He shows that the thickened "*cuticle*" of Unger, Mulder, Harting, &c., consists of secondary layers of cell-membrane, deposited from the inside, and infiltrated with some substance that is colored brown by iodine; with the exception of an extremely thin external pellicle, the real *cuticle* of Brongniart, which is probably a secretion from the surface of the cell, like that which forms the outer coat of pollen-grains. (p. 35.) He insists that the layer of protoplasm, his *primordial utricle*, lining the cell is a soft and delicate membrane, and not a mere layer of mucilage (p. 37); the mode in which this is constricted and a partition formed by an inward growth at the fold, in the multiplication of cells by division, is very clearly explained. (p. 50–53.) Free cell-formation is said to occur, in Phænogamous plants, only in the embryo-sac, in which both the embryonal vesicle, or rudiment of the embryo, and the cells of the albumen, originate in this manner; in the Cryptogamia, only in the formation of spores in certain cases, as in the Lichens (p. 58); contrary to the view of Schleiden, who long maintained this to be the universal, and lately a general, mode of cell-production. Schleiden's original account of the process of the formation of a free cell from a nucleus is directly controverted in all essential points; the nucleus, according to Mohl, being always central, and at no time connected with the cell-membrane, but always enclosed in the primordial utricle. A nucleus, or mass of nitrogenous substance first has the primordial utricle, or *nitrogenous membrane*, developed over its surface; and then the cell-membrane (of cellulose) is deposited upon this. In Cryptogamous plants, such masses, of larger or smaller size, may become coated with a cell-membrane without any proper nucleus appearing. (p. 57–60.) Thus much for what relates to the *anatomical condition of the cell.*

Under the second head, the *Physiological Condition of the Cell*, our author treats first, of the cell as an organ of nutrition, next, as an organ of propagation, and finally, as an organ of motion. He pronounces against the Knightian doctrine, that plants ultimately degenerate and perish when propagated for generation after generation by division (from the bud). (p. 64.) That the crude sap, though absorbed by the parenchymatous tissue of the root, ascends through the woody tissue, and that the assimilated sap returns through the bark, and thence more or less into the wood by means of the medullary rays, is very neatly shown. "A few simple experiments leave no doubt about this. * * If the bark of a plant, best of a tree, is cut through in a ring down to the wood, there is no interruption of the flow of sap to parts situated above the wound; but if the wood is cut through, the greatest care being taken to avoid injuring the bark, that portion of the plant above the wound dries up at once. From the wood of the stem and branches the sap flows onward into the leaves, as is proved by the powerful expiration of watery vapor from them. Before the sap has reached the leaves it is incapable of being applied to nutrition; consequently the vegetation of a plant comes to a stand-still when it is deprived of its leaves. The sap ascending from the root to the leaves is thence termed the crude sap. It undergoes a chemical change in the leaves, rendering it fit to be applied to the nutrition of the plant. To this end the sap flows backwards from the leaves through the bark to the lower parts, as the following circumstances testify. If the bark is cut off the stem in a ring, the growth of the portion below the wound stands as it were still; the stem becomes no thicker; in the potato plant no tubers are produced, &c.; but, on the other hand, the growth above the wound is increased beyond the usual measure, thicker layers of wood are deposited, more fruit is perfected, this ripens sooner, &c. The deposition of starch which occurs in the cells of the medullary rays in autumn, goes to prove, that the portion of assimilated sap which is not used for nutrition on the way to the root, runs back to the wood through these horizontal medullary rays; and thus the sap describes a kind of circle, not, indeed, in determinate vessels, but in a definite path leading through the different parts of the plant. It is difficult to conceive how in recent times the results of these experiments could have been questioned, and the existence of the descending current in the bark denied. Certainly it is no improvement on the theory cast aside, when the increased growth above the annular wound is explained by the artificial interruption of the upward current of crude sap, in consequence of which the sap contained in the upper part of the plant must soon become greatly concentrated and potential for development (Schleiden, *Grundzuge*, 2d ed., ii, 513). When we can succeed in fattening an animal by depriving it of a portion of its accustomed food, this explanation may be received as satisfactory." (p. 70, 71.) After some excellent points of criticism, Mohl concludes that the discovery of endosmose has not fully solved the problem of the movement of the sap in plants, although in all probability it does play an important, and perhaps the principal part in its absorption and conveyance. (p. 77.) To the question, whether plants live on inorganic food alone, or take in also organic matters, Mohl gives a sensible answer, rejecting the extreme view of Liebig, while still fully recognizing the great office and result of vegetation. (p. 78.) According to Mohl, however, it is proved that plants do not absorb the carbonic acid dissolved in water with the latter by means of their roots, (p. 81); but this seems hardly reconcilable with several facts stated on the next page, from which it is justly concluded that carbonic acid is carried up with the ascending sap into the leaves. From the fact that plants perish so soon in air deprived of all oxygen gas, that sensitive leaves lose their irritability under such circumstances, &c., Mohl concludes, apparently with good reason, that the absorption of oxygen and the exhalation of carbonic acid in plants is a true physiological function, intimately connected with the life of the plant; and that this (rather than the opposite and predominant *nutrient* process, through which carbonic acid is decomposed and oxygen evolved) should be considered as the respiration of plants, if we use that term at all. (p. 86.) "The roots of plants, and not the leaves, take up the substances which furnish plants with nitrogen, while, on the contrary, the leaves play the essentially active part in the absorption of carbonic acid." (p. 88.) The analogy of the milky juice of plants to the blood of animals, as propounded by Schultz, is thoroughly refuted by our author, and the flowing movement in the milk vessels described by Schultz, is positively denied to take place in an uninjured plant, except as produced by mechanical causes. That the milky juice is not a nutrient material, still less the nutrient juice, is also manifest. (p. 96.)

The cell as an organ of propagation is treated, first as respects the multiplication of plants by division; second, by spores; and third, by seeds. The conjugation of certain Confervoid Algæ, such as Zygnema, is said to bear no analogy to sexual reproduction (p. 113); a conclusion which may be questioned. A good summary is given of the facts known respecting the free and spontaneous movements of the spores of the lower Algæ (p. 115); and also of the recent discoveries respecting the bisexual reproduction of the higher Cryptogamia. The reprint of Henfrey's Report, in the January and March numbers of this Journal, has placed our readers *au courant* with the present state of knowledge on this interesting subject. It should be noticed that Mohl denies the existence of *antheridia* in lower Cryptogamia, or Thallophytes; but maintains that the small bodies, moving by two cilia, discovered by Decaisne and Thuret in the Fucaceæ, are more properly a second kind of spores, analogous to the small spores of the Florideæ, than of the nature of the seminal filaments of Ferns, Mosses, &c. (p. 117.) The later researches of Itzigsohn, Thuret, Tulasne, &c., however, lead rather to the conclusion that the lower Cryptogamia (except the very lowest) are likewise bisexual.*

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* *Itzigsohn,* in *Botanische Zeitung,* May, 1850.—Here it is announced that the black dots on the surface of the frond of Borrera ciliaris contain antheridia, that is, cells from which escape animalcular-like corpuscles that move freely in water, and are similar to those of Mosses and Liverworts. Later, after stating that others had failed to detect these movements, he announces that they had been observed by Rabenhorst, after many ineffectual trials. He also (Dec. 1850, Feb. 1851) states that these "spermatozoids" do not manifest vital movements until after the maceration of the Lichen in water for several days.

Tulasne (L. R.), Mémoire pour servir a l'Histoire Organographique et Physiologique des Lichenes; in Ann. Sciences Naturelles, 3rd ser., xviii, No. 1, 2, 3, 4, (1852,) with 16 plates.—A most admirable and complete memoir, elucidating in an unequalled manner, the whole structure and morphology of the *Lichenes.* It is to be hoped that the author will publish it in a separate form; as it introduces a new era in Lichenography. On the subject of the so-called Antheridia (which alone we can here notice), M. Tulasne has recognized the universal occurrence of these bodies in Lichens, has ascertained their structure and development; but he has never detected any free movement of the corpuscles, except the general molecular or Brownian motion, common to all minute particles. He therefore gives to the so-called Antheridia the name of *spermogonia,* and to the contained corpuscles the name of *spermatia.* He unhesitatingly recognizes in them an apparatus of reproduction, doubtless analogous, at least in function, to those of the Florideous Algæ, in which the corpuscles are equally motionless, and of certain Fungi, and therefore probably representing male organs. Tulasne likewise calls attention to the fact that these dark tubercles or dots were particularly noticed by Dillenius, more than a century ago, in Borrera ciliaris; and that Hedwig, in 1784, expressed the opinion that they constituted the male apparatus of Lichens.

Decaisne & Thuret, Recherches sur les Anthéridies et les Spores de quelques Fucus; in Ann. Sci. Nat., 3rd ser., iii, p. 5.—Here the corpuscles known to the earlier Algologists, and considered by Agardh and Montagne as a second kind of spores (a view which Mohl adopts), are announced to be the spermatozoids of the antheridia of Fucaceæ; their active movements are described, and the discovery of the two cilia is announced by whose vibration the movement is effected.

Thuret, Recherches sur les zoospores des Algues et les Anthéridies des Cryptogames.—These researches were communicated to the Academy of Sciences, Paris, and were rewarded by the great prize for natural sciences, in 1847. A copious abstract has been published in the *Ann. Sci. Nat.,* 3rd ser., xiv, and xvi, (1850, 1851,) with 30 plates. As to antheridia, bodies like the free-moving corpuscles of the Fucacaæ are shown likewise to occur in all the Florideæ, except that they do not exhibit spontaneous movements; nevertheless, M. Thuret does not hesitate to attribute to both the same functions as those which the seminal filaments of the higher Cryptogamia fulfill. The Antheridia of Chara (in which Thuret first discovered the cilia by whose vibration the coiled filaments are moved), of the Liverworts, Mosses, and Ferns, are also admirably illustrated; but nothing of consequence is added to the facts mentioned in Henfrey's Report.

Léveillé, in Ann. Sci. Nat., 3rd ser., 15, p. 119, has indicated the probable existence of the analogues of antheridia in Fungi.

Under the head of Reproduction by Seeds, Mohl gives an interesting and critical account of the development and structure of the pollen and the ovule, and of the origin of the embryo. The latter arises by cell-multiplication of the germinal vesicle, a cell produced by free cell-formation in the embryo-sac usually before the pollen-tube has reached the latter. The germinal vesicle and the extremity of the pollen-tube are separated by the thickness of the parieties of the embryo-sac. The penetration of the pollen-tube into the latter, or into an introverted portion of it, and the formation of the embryo from the apex of the pollen-tube itself, as taught by Schleiden, are wholly repudiated; and indeed the Schleidenian doctrine may now be considered as thoroughly demolished, by the direct observations of Amici, Mohl, Muller, Hofmeister, Unger, Henfrey, and Tulasne.

The Cell as an Organ of Motion is considered as respects movements of individual cells through the agency of vibratile cilia, as respects the directions and curvature assumed by organs, and as respects movements by irritation of stimuli, &c., giving an excellent summary of our knowledge on these points, with much admirable criticism; which want of space prevents us from noticing in detail. Our notice will have served its purpose if it direct attention to a treatise, small in compass and moderate in price, but of the highest authority on these subjects of common interest to all naturalists and physiologists. Mr. Henfrey's name is a sufficient voucher for the faithfulness of the translation. But, with equal correctness, the German might have been rendered into more flowing and idiomatic English. A. G.

2. *Dr. Hooker's Flora of New Zealand.*—The third part, which has now appeared, carries this work from the Ericaceæ to the Orchidaceæ, and the plates from pl. 41 to 60. A. G.

3. *The Oak-Vegetation of America, (Americas Ege-vegetation, &c.) abridged from two popular lectures delivered before the Association of Natural History of Copenhagen*, by Prof. LIEBMAN. Translated by Dr. WALLICH.—This is reproduced in Hooker's Journal of Botany for Dec. and January last, and is a very interesting article, especially that part of it which relates to the oaks of Mexico, where the author travelled and collected extensively. Prof. Liebmann is now, we believe, the successor of Prof. Schouw, the celebrated writer on the Geography of Plants, of whose lamented decease we have recent intelligence. A. G.

4. *Martius, Flora Braziliensis*, Fasc. XI, Liepsic, 1852, pp. 75, fol., with 24 plates. This new part of the Brazilian flora, the publication of which is again actively resumed, contains the *Piperineæ*, a class which is here made to include the *Chloranthaceæ* and the *Piperaceæ*, but not the *Saururaceæ*. Both are elaborated by Prof. Miquel of Amsterdam, the indefatigable monographer of the latter family. The order Chloranthaceæ is represented in Brazil by a single species of *Hedyosmum*. Exclusive of Piper nigrum, which is a cultivated plant, the Brazilian Piperaceæ belong to six genera, namely, *Peperomia*, 53 species; *Pothomorphe*, 4 species; *Enckea*, 4 species; *Peltobryon*, 5 species; *Artanthe*, 80 species; *Ottonia*, 19 species. Besides the illustrations of this family, a single physiognomical plate represents a scene in the primæval forests of Brazil. A. G.

V. Astronomy.

1. *New Comet*, (Astron. Journal, No. 54.)—A telescopic comet was discovered near star 63 in the Constellation *Eridanus*, March 8, 1853, by Mr. Chas. W. Tuttle, assistant at Harvard College Observatory.

2. *Thalia*, (Astron. Jour., No. 55.)—The following elements of this planet have been communicated by W. Oeltzen of Vienna. They are computed from observations at Liverpool Dec. 16, Berlin Dec. 29, and Hamburg, Jan. 11.

Epoch, 1852, December 29·37907, m. t. Greenwich.

Mean anomaly, - -	324° 30′ 35″·0	Mean Eqx. 1853·0.
Long. of asc. node, - -	67 52 42 ·0	
Inclination, - - -	10 19 27 ·0	
Angle between perih. and node,	54 44 27 ·7	
Angle of excentricity, -	12 31 26 ·1	
Log. of semi-axis major, -	0·212976	
" mean daily motion, -	2·930543	

3. *Fortuna*, (Astronom. Nachrichten, No. 836.)—The following elements were computed by Mr. Carl Bruhns from Berlin observations of Aug. 28, Sept. 27 and Oct. 27.

Epoch 1852, Sept. 27·354061.

Mean anomaly, - - - - -	325° 5′ 47″·7
" longitude, - - - - -	357 26 29 ·6
Long. of perihelion, - - - -	32 20 41 ·9
" asc. node, - - - - -	211 16 57 ·6
Inclination, - - - - -	1 32 35 ·0
Angle of excentricity, - - - -	9 48 18 ·9
Log. of semi-axis major, - - -	0·390678
" mean daily motion, - - -	2·963990

4. *Parallax of a Star.*—In a previous No. of this Journal* it was stated that M. H. Faye, of Paris, had found for the parallax of an unnamed star in *Ursa Major* (1830 of Groombridge's Catalogue of Circumpolar Stars) 1″·06. M. Peters, on the contrary, made it only 0″·23; M. Wichmann, 0″·18; and M. Otto Struve, 0″·03. In these investigations it was assumed that the stars of comparison had no parallax. M. Wichmann has continued his labors upon this star, and the new results to which he has arrived are given in part in a letter to M. Faye; a part of which is here given in translation from the *Comptes Rendus* (tom. 35, p. 859, Dec. 13, 1852).

"During the past year I have made with the aid of the heliometer a new series of observations upon this star (1830 G.) using for comparison not only the stars selected by Schlueter, but also the star used by yourself. This last I designate by *a*″, and those of Schlueter by *a* and *a*′; (*a*′ and *a*″ being situated upon one side of 1830 G. and *a* upon the

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* 2d Series, vol. iii, p. 444.

opposite side.) The result of my researches may be expressed as follows:

1. The parallax of a'' is equal to that of a'.
2. The parallax of a is $1''\cdot17$ greater than that of a'.
3. The parallax of 1830 G. is $0''\cdot14$ greater than the arithmetical mean of the parallaxes of a and a'; i. e., it is $0''\cdot72$ greater than the parallax of a' or of a''.

Thus the mysterious discordance which before existed between the parallax obtained by you in 1846, and that given by the Königsberg heliometer is explained by the interesting fact that the star of comparison a is nearer to us than 1830 G. You know that my reduction of the observations made by M. Schlueter gave for the parallax of 1830 G. $0''\cdot18$, on the supposition that the stars of comparison had no parallax, a result obtained by the discussion of differences of distance. But in the sum of the distances, which should be constant, there was shown an annual and periodic change, whose cause was unknown. These results are confirmed by my new observations; the same annual variation is presented, in the same direction, and of the same amount. To explain this I have formed two hypotheses; one, that this variation in the sum of the distances is caused by the influence of temperature on the parts of the instrument; the other, that it results from a difference in the parallaxes of the stars of comparison. The last hypothesis represents the observations very well, without leaving periodic errors of much magnitude, while the first, even giving to the action of heat a value three to five times as great as that found by Bessel, cannot represent the observations, and it leaves residuary errors which are wholly improbable. Upon the second hypothesis the observations made by Schlueter accord remarkably well with mine. Supposing the parallax of the stars a' and $a''=0$, we have the parallaxes,

	Of 1830 G.	Of the star *a*.
By Schlueter's observations,	$=0''\cdot75$	$=1''\cdot15$
By my "	$=0''\cdot68$	$=1''\cdot19$

Or if we deny the difference of parallax of the stars of comparison, it will necessarily result from the observations made with the heliometer that the parallax of 1830 G. is less than $0''\cdot2$; for these observations are arranged in such a manner, as you will see in my memoir,* that the differences of distance and the consequent result are wholly free from the influence of the periodic change which is manifested in the sum of the distances, whatever may be the cause of it. The inevitable alternative is, that the parallax of 1830 G. is less than $0''\cdot2$, a value not at all probable, or that the star a is nearer to us than 1830 G. I have no doubt that the last, which is indicated by the observations, is the truth; and I believe this interesting result is established so surely by the heliometric measures, that it will be very difficult to prove that the large parallax of this star of comparison which I have found does not exist."

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* Astronomische Nachrichten, Nos. 840–844.

VI. MISCELLANEOUS INTELLIGENCE.

1. *Meteorological Observations at Burlington, Vt.;* by Z. THOMPSON.—Mr. Thompson adds the following to his paper at p. 385. List of the appearances of the Aurora Borealis observed at Burlington in 1852:

Jan. 19, distinct arch and streamers; 21, part of an arch in the N. E.; 23, faint auroral light; 25, ibid.; 26, ibid.

Feb. 16, faint auroral light; 18, two distinct concentric arches, the vertex of one being about 8° and the other 18° high.

Feb. 19, very splendid aurora, appeared soon after sunset, at first in the form of an arch, spanning the heavens from N. W. to S. E. and passing 8° or 10° S. W. of the zenith, the northwestern position being strongly tinged with red and umber. At the vertex of the arch, there was the appearance of radiation. The meteor continued moving and flashing over the northern half of the heavens during the whole night, and was visible till nearly sunrise the next morning. 27, two distinct arches with streamers.

March 7. Meteor moderate—no distinct arch; 10, meteor faint; 16, aurora very bright but low in N.; 19, aurora borealis low in N.; 20, ibid.

April 8, aurora borealis faint; 13, aurora very bright in the N.; 14, ibid.; 17, faint; 20, ibid.

May 3, aurora borealis faint; 5, ibid.; 8, ibid.; 9, ibid.; 14, ibid.; 18, distinct arch.

June 11, aurora borealis very splendid—motions exceedingly rapid; 16, aurora glow with streamers.

July 5, aurora, with faint streamers; 12, auroral arch 15° in N. at 9 P. M.

Aug. 10, aurora borealis faint; 11, ibid. in N. E.

Sept. 6, aurora borealis broad arch—vertex of the under margin 11° high at 9 P. M., and well defined; 17, aurora arch about 8° high from 7 to 9 P. M.; 18, slight aurora borealis.

Oct. 5 and 6, slight aurora borealis.

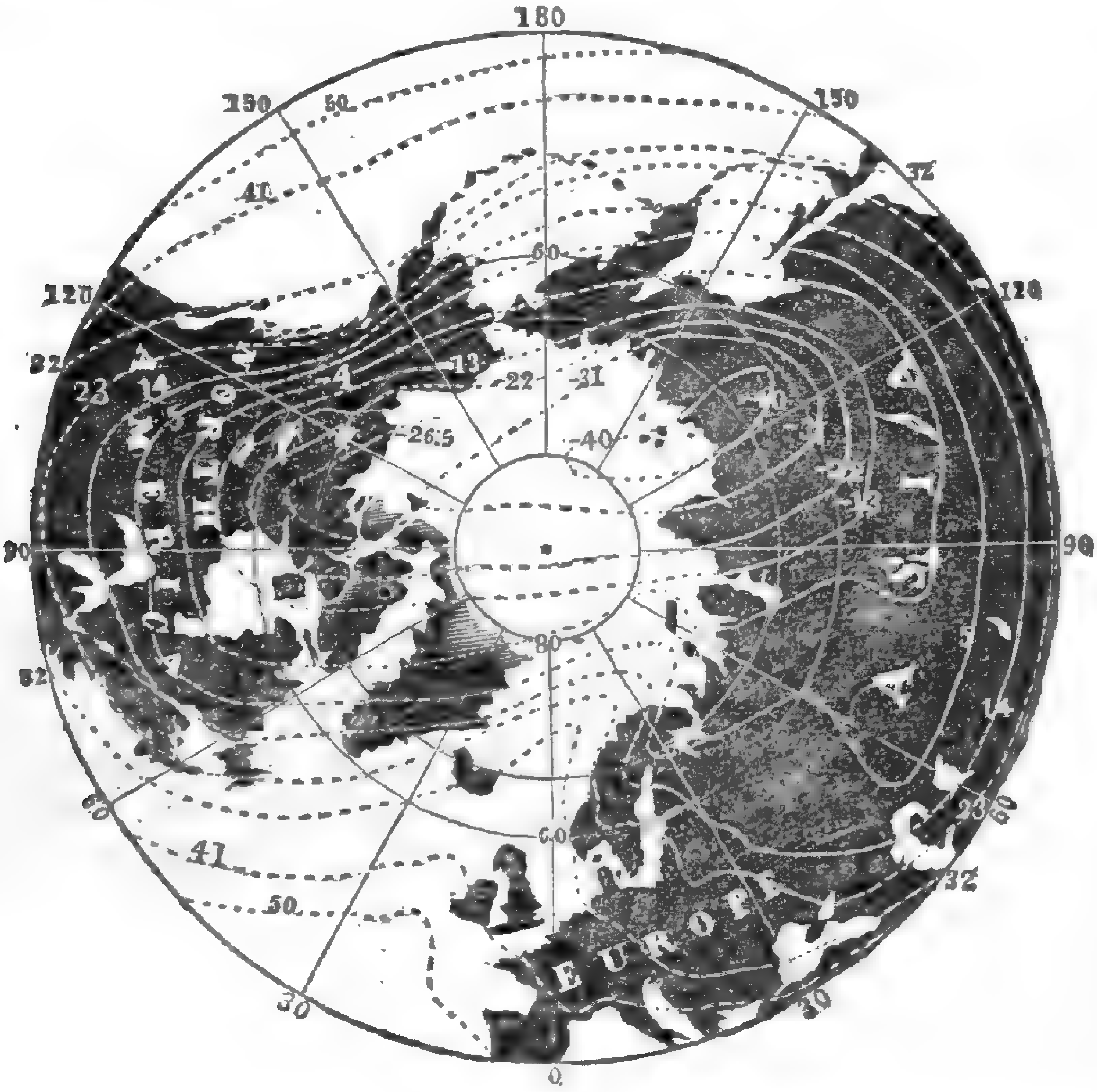
Nov. 11, splendid aurora borealis from 7 to 9 P. M. At 8¾h. two arches, one 15° and the other 30° high under the N. pole, with short streamers under the lower arch. At 9, very bright streamers in N. E., arches not well defined; 19, slight aurora in N. E.

Dec. 8, slight aurora in N. E.

2. *Chart of Isothermal Lines.*—A chart of isothermal lines accompanies this volume, illustrative of Mr. W. Hopkins's paper on Changes of Climate, especially the part from pages 72 to 86. This chart is from Dove's Isothermal Charts, the upper half being copied from his chart for January, and the lower half from that for July; and it is thus a winter chart throughout. The lines mark degrees of Fahrenheit. Those north of the equator are 77°, 68°, 59°, 50°, 41°, 32°, 23°, 14°, 5°, —4°, —13°, —22°, —26°·5, —31°, —40°, differing thus 9° Fahrenheit (equivalent to 4° Reaumur or 5° Centigrade). The line of 77° passes through those points which have 77° for the mean temperature for January; and so on. South of the equator, the lines are the same, but are twice nearer, the temperatures differing by 4½° F.

On the annexed cut, also copied, of reduced size, from Dove, the same lines north of the equator are shown on a north pole view of the globe; it exhibits the region of greatest cold about northern Asia.

Many deductions flow from such a chart. We allude only to one in this place. To the north, on the parallel of 60°, the mean temperature of the earth varies from —26½° F. (in northern America) to —13°, —4°, +5°, +14°, +23°, +39°, +40° (in the northern Atlantic); then decreases again regularly to —40°, the intense cold of northern Asia; and then again increases to +23°. Such a wide variation of temperature on the same parallel, contrasts strikingly with the near uniformity along the line of 60° south; and it suggests reasons for electrical and other meteorological disturbances on a grand scale at the north, which can have no parallel at the south.



3. *Belcher's Artesian Well, in St. Louis*, (from the St. Louis Republican.)—Allusion was made a few days since to the progress of the Artesian well that Mr. Wm. H. Belcher is sinking in the upper part of the city to supply his extensive sugar refinery with other than limestone water, which only can be found by the ordinary channels in this vicinity. The well, which we think was commenced early in the year 1849, has now attained the great depth of 1590 feet. The boring still progresses without intermission, night and day, the hands, six in number, relieving one another by regular watches. The iron "sinker," with which the drilling is effected, is 34 feet in length, 2½ inches in diameter, and between 700 and 800 pounds in weight. It is attached to poles, severally about 30 feet long, that are screwed to each other to extend to the full depth of the well. The whole is moved by a "doctor," worked by the boilers used for the refinery engines. Sev-

eral veins of impure water have been struck in the course of the excavation, to rid the well of which, a pump, also worked by the "doctor," is constantly in operation. At the present depth of 1590 feet a pretty copious stream of sulphur water issues from the well. The water has the taste precisely of the Blue Lick water in Kentucky, though perhaps not quite so strongly impregnated with sulphur. We have obtained from the gentleman who superintends the boring, an exhibit of the different strata through which he has passed. The statement possesses sufficient interest for publication:

1st, Through limestone, 28 feet; 2d, shale 2; 3d, limestone 231; 4th, cherty rock 15; 5th, limestone 74; 6th, shale 30; 7th, limestone 75; 8th, shale 1½; 9th, limestone 38½; 10th, sandy shale 6½; 11th, limestone 128½; 12th, red marl 15; 13th, shale 30; 14th, red marl 50; 15th, shale 30; 16th, limestone 119; 17th, shale 66; 18th, bituminous marl 15; 19th, shale 80; 20th, limestone 134; 21st, cherty rock 62; 22d, limestone 138; 23d, shale 70; 24th, limestone 20; 25th, shale 56; 26th, limestone 34; white soft sandstone 15 feet.

The well was first commenced, we understand, as a cistern. From the surface of the ground, where it is fourteen feet in diameter, it has a conical form, lessening at the depth of thirty feet to a diameter of six feet. Thence the diameter is again lessened to sixteen inches, until the depth of 78 feet from the surface is attained. From that point it is diminished to nine inches, and this diameter is preserved to the depth of 457 feet. Passing this line the diameter to the present bottom of the well, is three and a half inches.

The lowest summer stand of the Mississippi river is passed in the first strata of shale, at a depth of twenty-nine or thirty feet from the surface. The water in the well, however, is always higher than the water line of the river, and is not affected by the variations of the latter. The first appearance of gas was found at a depth of 466 feet, in a stratum of shale one and a half feet thick, which was strongly imbued with carbonated hydrogen. When about 520 feet below the surface of the earth, at the beginning of a layer of limestone, the water in the well became salty. The level of the sea—reckoned to be five hundred and thirty-two feet below the city of St. Louis—was passed farther in the same layer; two hundred feet lower still, in a bed of shale, the water contained 1⅞ per cent. of salt. At a depth of 950 feet a bed of bituminous marl, 15 feet in diameter, was struck. The marl nearly resembled coal, and on being subjected to great heat, without actually burning, lost much of its weight. In the stratum of shale which followed, the salt in the water increased to 2¼ per cent. The hardest rock passed, was a bed of chert, struck at a depth of 1179 feet from the surface, and going down 62 feet. In this layer, the salt in the water increased to full three per cent. The boring at present, is, as appears by the statement above, in a bed of white soft sandstone, the most promising that has yet been struck for a supply of water, such as is wanted.

Observations have been made with a Celsius thermometer of the temperature of the well. At the mouth of the orifice, the thermometer marks 50 degrees; at the depth of 45 feet, the heat is regular, neither increasing nor diminishing with the variations above, and at the distance of 1351 feet, the heat has increased to 69 degrees.

The Artesian well of Mr. Belcher is already one of the deepest in this country; it is considerably more than half the depth of the celebrated Artesian well in Westphalia, Germany, which is sunk 2,385 feet. If the recent indications do not deceive, a supply of sweet pure water will be soon obtained.

4. *Washington Territory.*—Among the few acts of positive legislation consummated at the Session of Congress just concluded, that organizing the new *Territory of Washington* is one of the most important and interesting.

"Washington Territory" (so named with singular inappropriateness, and, contributing fresh confusion to our already confused nomenclature) comprises the northern portion of the recent Oregon Territory, and is bounded on the south by the Columbia river, up to near Fort Walla-Walla, (some two hundred and ninety miles,) where the parallel of 46° of latitude intersects it; thence by this parallel to the crest of the Rocky Mountains; thence the boundary follows this mountain crest to latitude 49°, and thence runs west on this parallel to the Gulf of Georgia and the Straits of de Fuca to the Pacific, by which it is limited on the west. We derive from a scientific and well-informed source some particulars respecting this Territory, not readily accessible to the public, which we present to our readers.

"Washington Territory" lies chiefly between latitudes 46° and 49° and between longitudes 110° and 125° west of Greenwich. The boundary initial points and parallels must soon be accurately determined, and it must be decided where the crest of the Rocky Mountains really is. This latter problem may not be easy of solution, for Lewis & Clark, Father de Smet, the Irving Astoria Map, and the Indian Bureau and Topograpical Bureau maps all represent these mountains differently. Lewis & Clark exhibit four distinct ranges, with which the best recent explorations essentially agree; indicating at least three parallel ranges running nearly northwest, instead of the more prevalent indication of a single north and south range. Exploration may show the necessity of a more definite eastern boundary. On the north the mouth of Frazer's river is so near to latitude 49° that a portion of it may be found to fall in the United States, though this is improbable. There are thus several important geographical questions connected with the boundaries of this neophyte State.

"Washington Territory" has within its limits portions as well explored and others as nearly unknown as can be found west of the Mississippi. The Columbia river was thoroughly surveyed by Capt. Wilkes, two sheets out of six being now published. It was surveyed by Belcher, in 1839, and two sheets are published among the Admiralty charts. The Coast Survey has twice surveyed its mouth, and published one sheet. A comparison of these several surveys with Vancouver's indicates a remarkable degree of shifting in the sand-banks at its mouth. Shoalwater Bay has been surveyed by the Coast Survey, but the survey is not published. Grey's Harbor has also been just surveyed, and this, with Chickalees river, has been surveyed, and the survey published by Capt. Wilkes. The Admiralty charts cover the Straits of de Fuca and many harbors on the mainland and on Vancouver's Island. A Coast Survey reconnoissance has now extended up the entire Pacific coast and along the south coast of the Straits of de Fuca, and will soon be published. The surveys under Captain Wilkes and his narrative give full information of all the groups of islands in the Gulf of Georgia, and the channels leading to and making up Puget's Sound, with much detail. The shores of this wonderful network of channels are so favored in soil and location that they must soon possess great value. Through a surprising extent of line they are directly accessible for ocean vessels, and form, as it were, an immense network of harbor. They present the foundation for a kind of agricultural Venice, far into the heart of the west half of Washington, the resources of which they will greatly aid in developing. Fort Nisqually and Olympia, at the southern extremity of Puget's Sound, must rapidly advance with the growth of the Territory.

The interior portion of this section is but imperfectly known. The land office surveys north of the Columbia have as yet made little progress; but the sketches prepared in that office give more recent and correct information than is elsewhere to be found on the section between that river and Puget's Sound. On penetrating farther towards the Rocky Mountains, the country is essentially unknown. The narrative of Lewis and Clark, the book on Oregon Missions, by Father de Smet, published in New York in 1847, and Irving's Astoria (the last edition) are the chief publications of value on this ground. These serve merely to show that the country bordering the Rocky Mountains between 46° and 49°, on both sides, is still a good field for exploration. Much may be expected from Dr. Evans, who is engaged in a geological reconnoissance of the old Oregon Territory, which has taken him much among the Rocky Mountains, and over their basal plains.

With a field every way so requiring examination, it is fortunate that the newly-appointed Governor of Washington possesses so many peculiar qualifications for his station, and especially a thorough training in geographical science. *Gov.* STEVENS, late a Lieutenant and Brevet Major of the Corps of Engineers, and now just entering on his duties as Governor of "Washington Territory," has been the Assistant in charge of the Coast Survey Office for over three years. A head graduate at West Point, a highly efficient constructing officer of Engineers, distinguished on Gen. Scott's staff in Mexico, he has discharged the laborious and difficult administrative duties of his recent position in so excellent a manner as to elicit frequent encomiums from Professor Bache, the Superintendent of the Coast Survey, and to afford every guarantee that he will make himself most usefully felt in the sphere on which he is entering. We expect, from his energy, from his liberality of views and attainments, that he will not permit his present term to expire without presenting to the public a tolerably complete map of the Territory, and such reports as will give a clear conception of the surface, soil, resources, products, and peculiarities of a region, so soon to become a State with a voice in our National Councils. Those who best know him are confident he will be able to accomplish this, and much more, in addition to those important and laborious duties which will devolve on him in organizing and putting into thorough operation the machinery of a new Territorial Government. H.

OBITUARY.

Anthony D. Stanley, Professor of Mathematics in Yale College, died on the 16th of March, aged 43 years. Mr. Stanley held the office of Tutor in Yale College from 1832 to 1836, when he was appointed Professor of Mathematics; and after two years in Europe, he entered upon his new duties in 1838. From that period to 1849, he pursued the life of a faithful teacher and was besides untiring in his studies and investigations. His principal contribution to this Journal appeared in the third volume (1847). He published also an elementary Treatise on Spherical Geometry and Trigonometry, and a volume of Logarithmic and other Mathematical Tables. The latter work was one of vast labor, as he undertook the thorough revision of existing tables; and in the course of it he detected several errors in the tables of Callet, Vega, Babbage and Shortrede. The work was printed with extreme care, and but two errors have yet been pointed out. A severe cold, taken in 1849, ended finally in settled consumption, from which he found but partial relief in a visit during 1850 to Egypt and Syria. After his return he resumed for a while his duties in college, but soon left them and retired to his home in East Hartford, where he died. Prof. Stanley was a man of deep devotion to his favorite pursuit, of great ability and accuracy in research, and of the highest moral worth. A natural diffidence and reserve led him to withhold from publication much that would have proved an honor to himself and of value to science.

Von Buch.—This eminent geologist died at Berlin, on the 4th of March, aged 79 years. The following is a letter from Humboldt to Sir R. I. Murchison, announcing his death, (Athenæum, No 1324).

"That I should be destined—I, an old man of eighty-three—to announce to you, dear Sir Roderick, the saddest news that I could have to convey:—to you for whom M. de Buch professed a friendship so tender, and to the many admirers of his genius, his vast labors, and his noble character! Leopold De Buch was taken from us this morning by typhoid fever, so violent in its attack that two days only of danger warned us. He was at my house so lately as the 26th [ult.], despite the snow and the distance between us, talking geology with the most lively interest. That evening he went into society; and on Sunday and Monday (the 27th and 28th) he complained of a feverish attack, which he believed to be caused by a large chilblain swelling from which he had suffered for years. The inflammation required the application of leeches, but the pain and the fever increased. He was speechless for thirty-eight hours. * * He died surrounded by his friends,—most of whom knew nothing of his danger till Wednesday evening, the 2d of March.

"He and I were united by a friendship of sixty-three years,—a friendship which never knew interruption. I found him in 1791, in Werner's house in Freiburg, when I entered the School of Mines. We were together in Italy, in Switzerland, in France,—four months in Saltzburg. M. De Buch was not only one of the great illustrations of his age,—he was a man of noble soul. His mind left a track of light wherever it passed. Always in contact with Nature herself, he could well boast of having extended the limits of geological science. I grieve for him profoundly,—without him I feel desolate. I consulted him as a master; and his affection (like that of Gay Lussac and that of Arago who were also his friends) sustained me in my labors. He was four years my junior,—and nothing forewarned me of this misfortune. It is not at the distance of a few hours only from such a loss, that I can say more respecting it. Pity me,—and accept the homage of my profound respect and affectionate devotion."

VII. Bibliography.

1. *Cosmography or Philosophical Views of the Universe;* by Charles F. Winslow, M.D. 174 pp. 16mo. Boston, 1853. Crosby and Nichols.—This volume treats in Part I, of the "Development of the Theory of Repulsion as a Planetary, Solar and Universal Force;" Part II, includes an application of the Theory of Repulsion to the Creation of the Universe; Part III, treats of the "Inequalities of Surface in the solid spheres and the successive Revolutions observed throughout the Crust of our Globe, as Results of the Alternating Intensity of Cosmical Forces." The views are in a few points novel, but our own opinions are quite at variance with the author's conclusions.

2. *Handbook of Universal Geography*, being a Gazetteer of the World. Edited by T. Carey Callicot, A.M. 856 pp. 12mo. New York, 1853. G. P. Putnam & Co. A very excellent Gazetteer, embracing a large compass with great fullness. The notices of places are brief, and by this means it is rendered wonderfully comprehensive, considering the size of the work.

3. *Elements of Geology;* by Alonzo Gray, A.M., author of Elements of Chemistry and Elements of Natural Philosophy, and C. B. Adams, A.M., Fellow of the Amer. Acad. of Arts and Sciences, Prof. in Amherst College, &c. 354 pp. 12mo. 1853. Harper & Brothers. —This work is a brief review of the elements of Geology, prepared for instruction in Schools and Colleges. It commences with an account of the various agencies employed in producing changes in the earth's surface, inorganic and organic, and thence proceeds to the arrangement, structure and historical relations of the earth's strata. It is illustrated by many wood-cuts.

4. *Catalogue of North American Reptiles in the Museum of the Smithsonian Institution.* Part I. SERPENTS: by S. F. Baird and C. Girard. Washington: Smithsonian Institution. 172 pp. 8vo. Jan., 1853.—Although styled a Catalogue, this volume contains descriptions of many new genera and species, with extended original observations.

5. *Annual Report of the Superintendent of the Coast Survey*, showing the progress of that work, during the year ending November, 1851. 558 pp. 8vo. Washington, 1852, 32d Congress, 1st session, Ex. Doc. No. 3.—We have already cited from this able Report the report of G. Mathiot on Electrotyping as employed by the Coast Survey.

6. *A Synopsis or Systematic Catalogue of the Medicinal Plants of the United States;* by A. Clapp, M.D. 222 pp. 8vo. Philadelphia, 1852. Presented to the American Medical Association, at its session in May, 1852.—This catalogue by Dr. Clapp has been prepared with much care, and contains notes both medical and historical, which add greatly to its interest and value.

7. *Natural History of New York: Palæontology*, vol. ii, by James Hall. 362 pp. 4to, with 102 plates. We take special pleasure in announcing the publication of this very valuable volume, the second on the Palæontology of New York, by Mr. Hall. The plates are beautifully executed, and the whole is an honor to the country as well as to the State under whose auspices it is published.

8. *Journal of the Academy of Natural Sciences*, [2], ii. Part III. pp. 185–276, with plates 17 to 24, 4to. Philadelphia, January, 1853.

Art. XX. Isaac Lea: Description of a Fossil Saurian of the New Red Sandstone Formation of Pennsylvania; with some account of that Formation.

XXI. Isaac Lea: On some New Fossil Molluscs in the Carboniferous Slates of the Anthracite Seams of the Wilkesbarre Coal Formation.

XXII. J. Leidy: On the Osteology of the head of Hippopotamus, and a description of the Osteological Characters of a new genus of Hippopotamidæ.

XXIII. J. L. Le Conte: Synopsis of the species of Pterostichus Bon. and allied genera inhabiting temperate North America.

XXIV. J. Cassin: Description of new species of Birds of the genera Melanerpes, Swainson, and Lanius, Linnæus.

XXV. A. L. Heermann: Notes on the Birds of California, observed during a residence of three years in that country.

XXVI. T. A. Conrad: Descriptions of New Fossil Shells of the United States.

9. *Crustacea of the U. S. Exploring Expedition under Capt. C. Wilkes;* by James D. Dana. 4to. Part I, including 680 pages, was published in December last. Part II, the conclusion of the work, embracing 940 pages, will appear the coming month. The plates will be longer delayed; they will make a large folio volume of 96 plates, partly colored. We defer a farther notice to our next.

Japan, an account Geographical and Historical; by Charles MacFarlane, Esq., author of British India, &c. 365 pp. 12mo, with numerous illustrations. *New York*, 1852. G. P. Putnam & Co.

Brief Astronomical Tables conducted on a simple Plan for the Expeditious Calculation of Eclipses in all ages, designed for the purpose of verifying dates. (The subject of a Paper read before the Isle of Wight Philosophical and Scientific Society on March 1st, 1852.) By W. Drew Snooke, Prof. Math. and Astronomy. 32 pp. 8vo. *London*, 1852. S. Highley & Son, 32 Fleet Street. *2s. 6d.*

Proceedings Acad. Nat. Sci. Philadelphia, vol. vi, No. vii, 1853.—p. 224. Remarks on the genus Dipodomys; *J. L. Le Conte.*—p. 226. Descriptions of twenty new species of U. S. Coleoptera; *J. L. Le Conte.*—p. 235. Description of a new species of Pouched Rat, of the genus Dipodomys, (D. Ordii); *S. W. Woodhouse.*—p. 236. New Reptiles from California; *E. Hallowell.*—p. 242. A new Mouse of the genus Hesperomys; *S. W. Woodhouse.*—p. 243. Synopsis of the Family of Naiades of North America, and a Table of some of the genera and subgenera of the Family according to their geographical distribution, and descriptions of genera and subgenera; *T. A. Conrad.*—p. 269. An enumeration of the Vines of North America, by J. L. Le Conte. F.L.S.—p. 274. Synopsis of the Silphales of America, and North of Mexico; *J. L. Le Conte.*—p. 287. Synopsis of the species of the Histeroid genus *Abræus*, Leach, inhabiting the United States, with descriptions of two nearly allied new genera; *J. L. Le Conte.*—p. 292. Chemical examination of remains of Fossil Mammalia; *F. V. Greene.*—p. 296. On a new variety of Gray Copper, perhaps a new mineral; *Dr. F. A. Genth.*—p. 297. On Owenite, a new mineral; *Dr. F. A. Genth.*—p. 299. On a new species of Scalops; *J. Cassin.*—p. 300. List of Reptiles collected in California by J. L. Le Conte; *S. F. Baird* and *C. Girard.*

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U. S. Coast Survey. A. D. Bache, Superintendent.

Illustrations accompanying the Report of the Electrotype Department U. S. Coast Survey Office

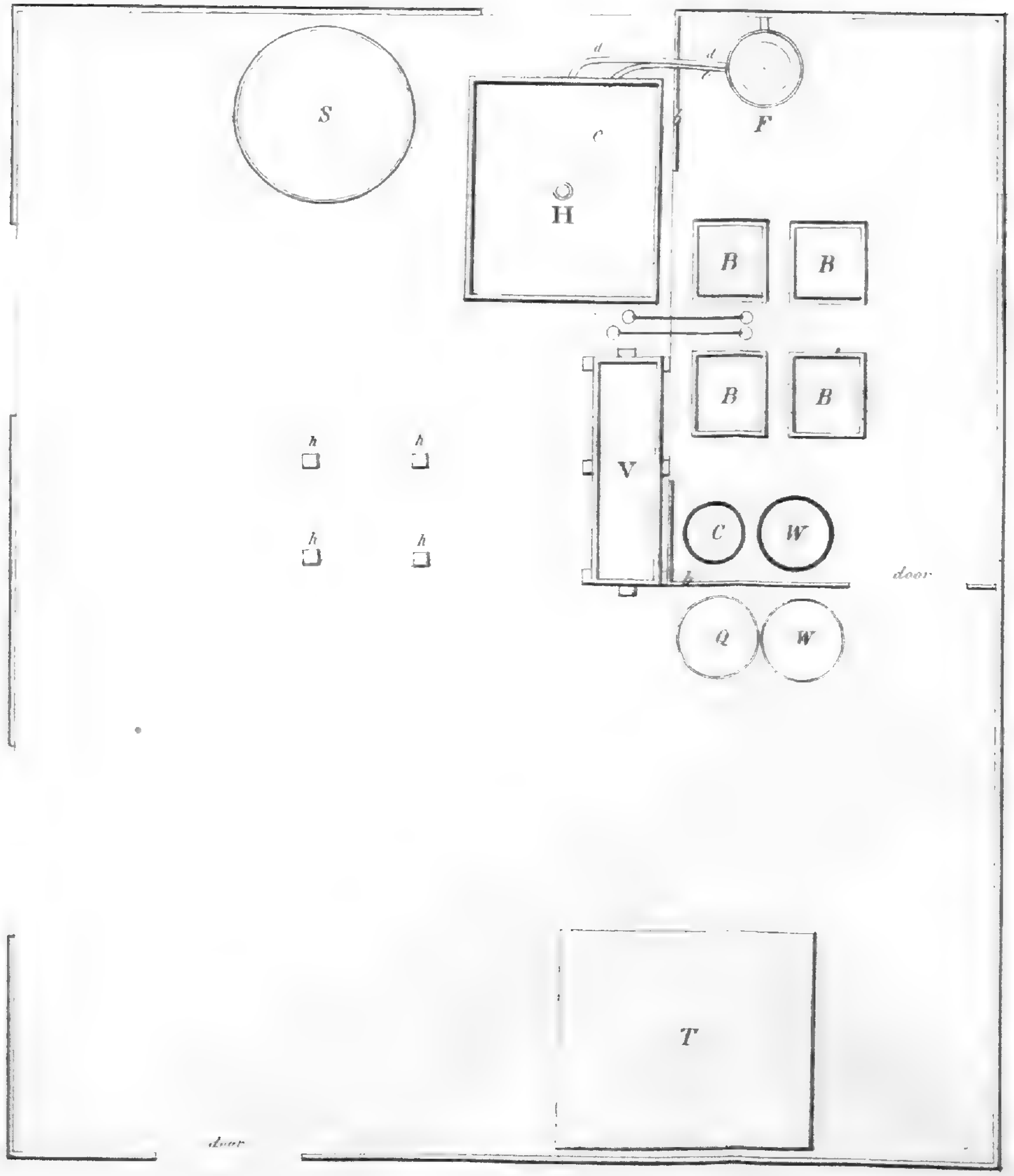
1851

Fig. 1

Plan of the Laboratory

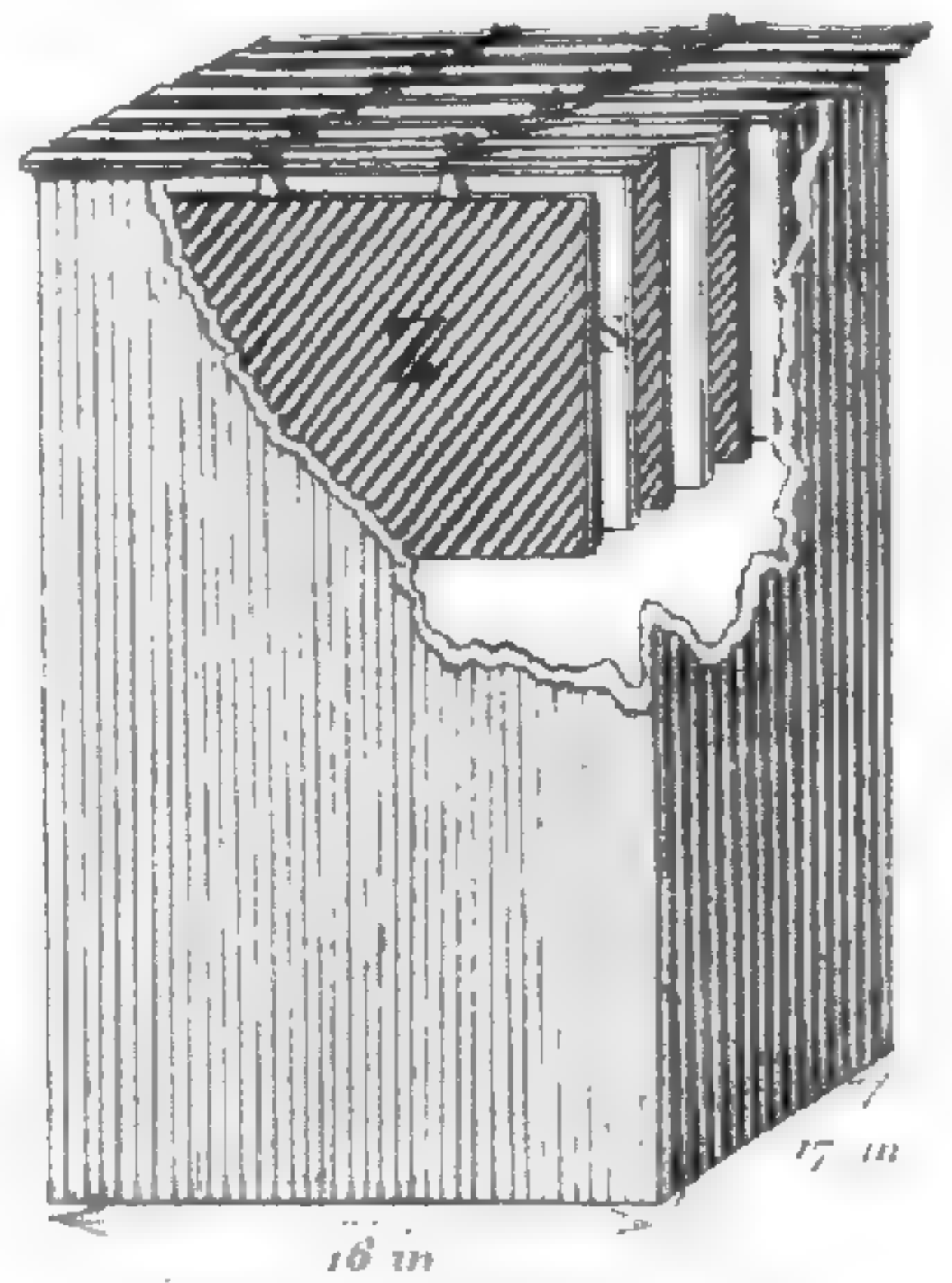
Showing the arrangement of the Electrotype Apparatus

in the U. S. Coast Survey Office.



Scale 1 inch to 4 feet

Fig. 2



Zinc Plates are shaded

Fig. 4

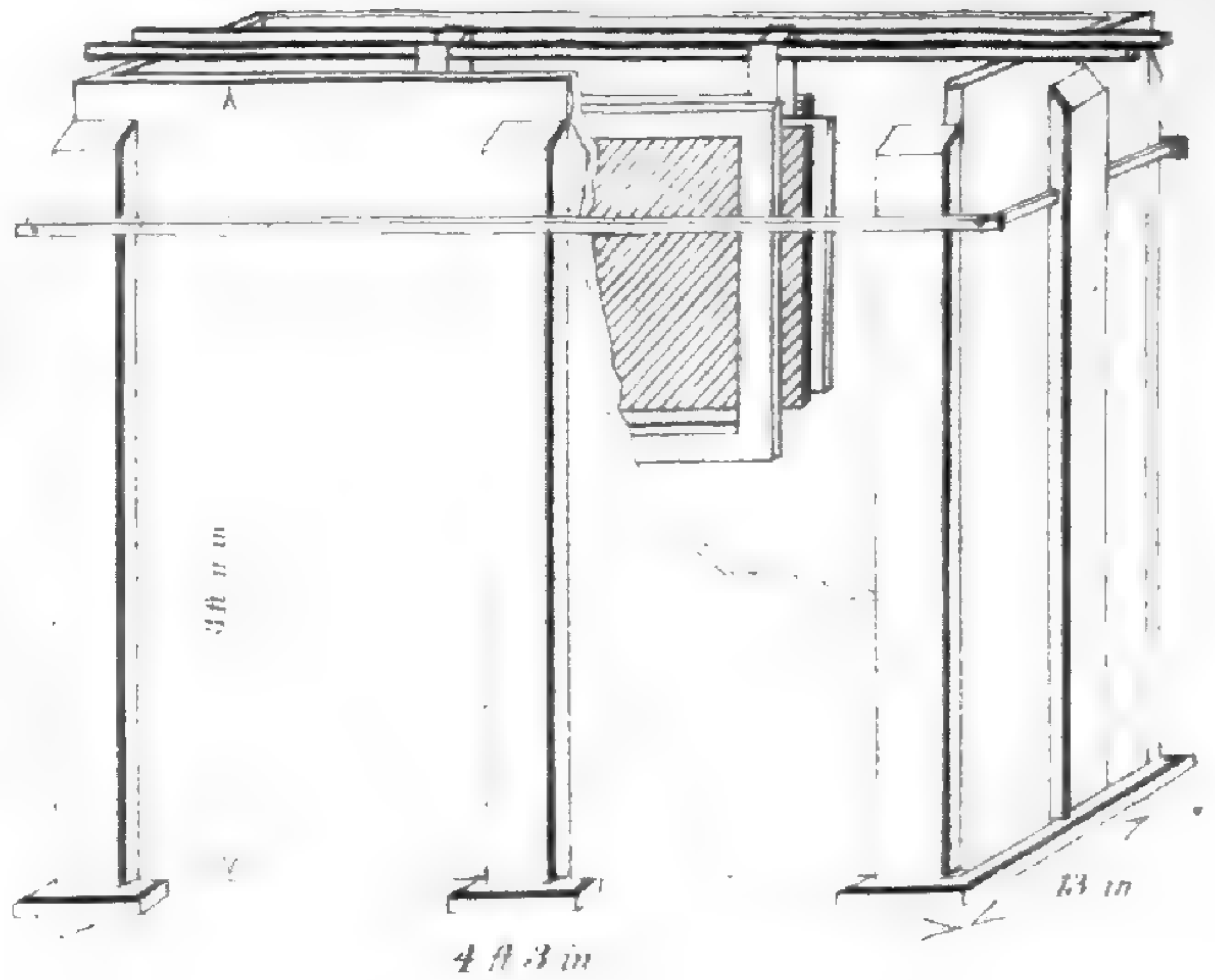


Fig. 5

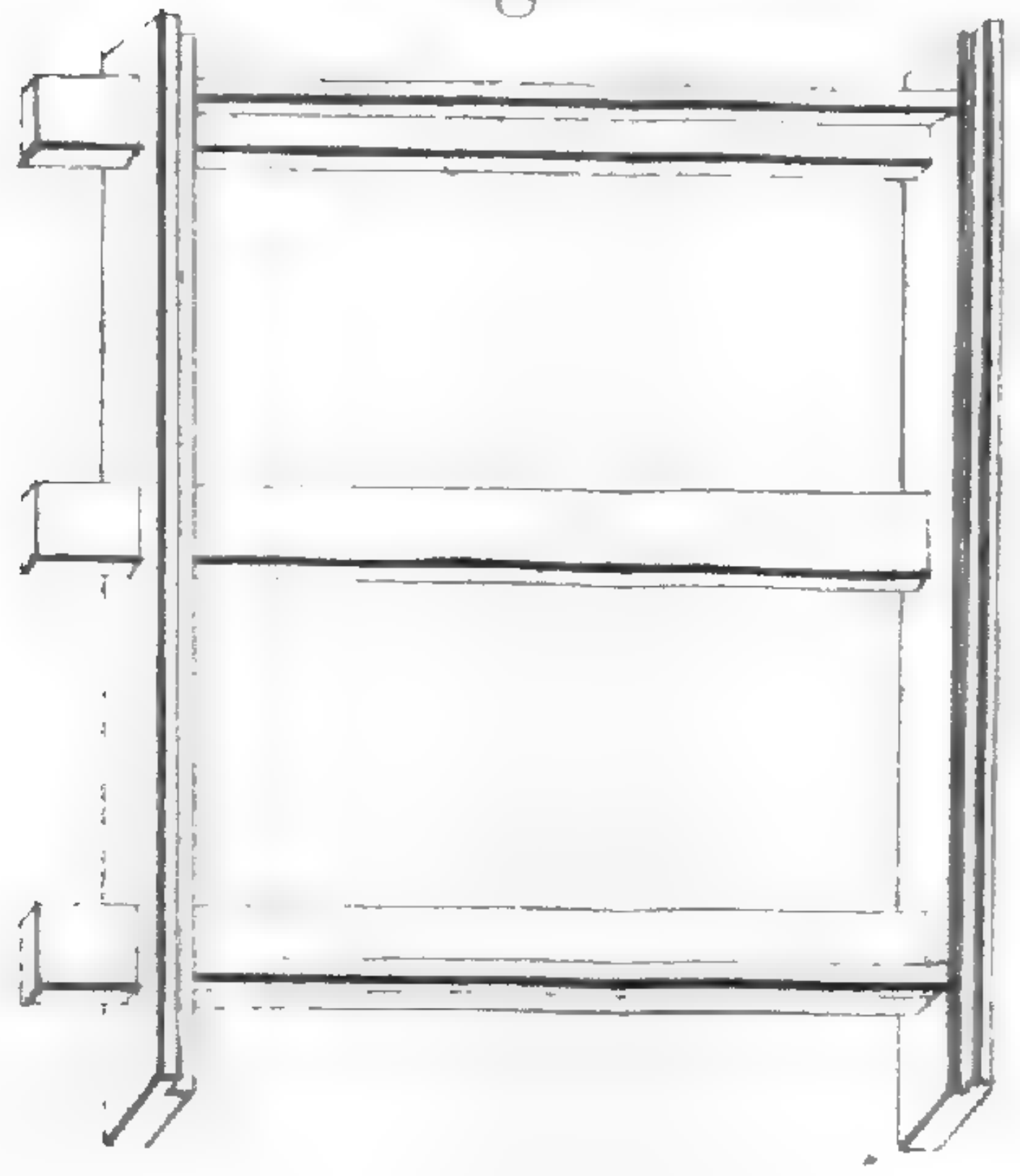


Fig. 3

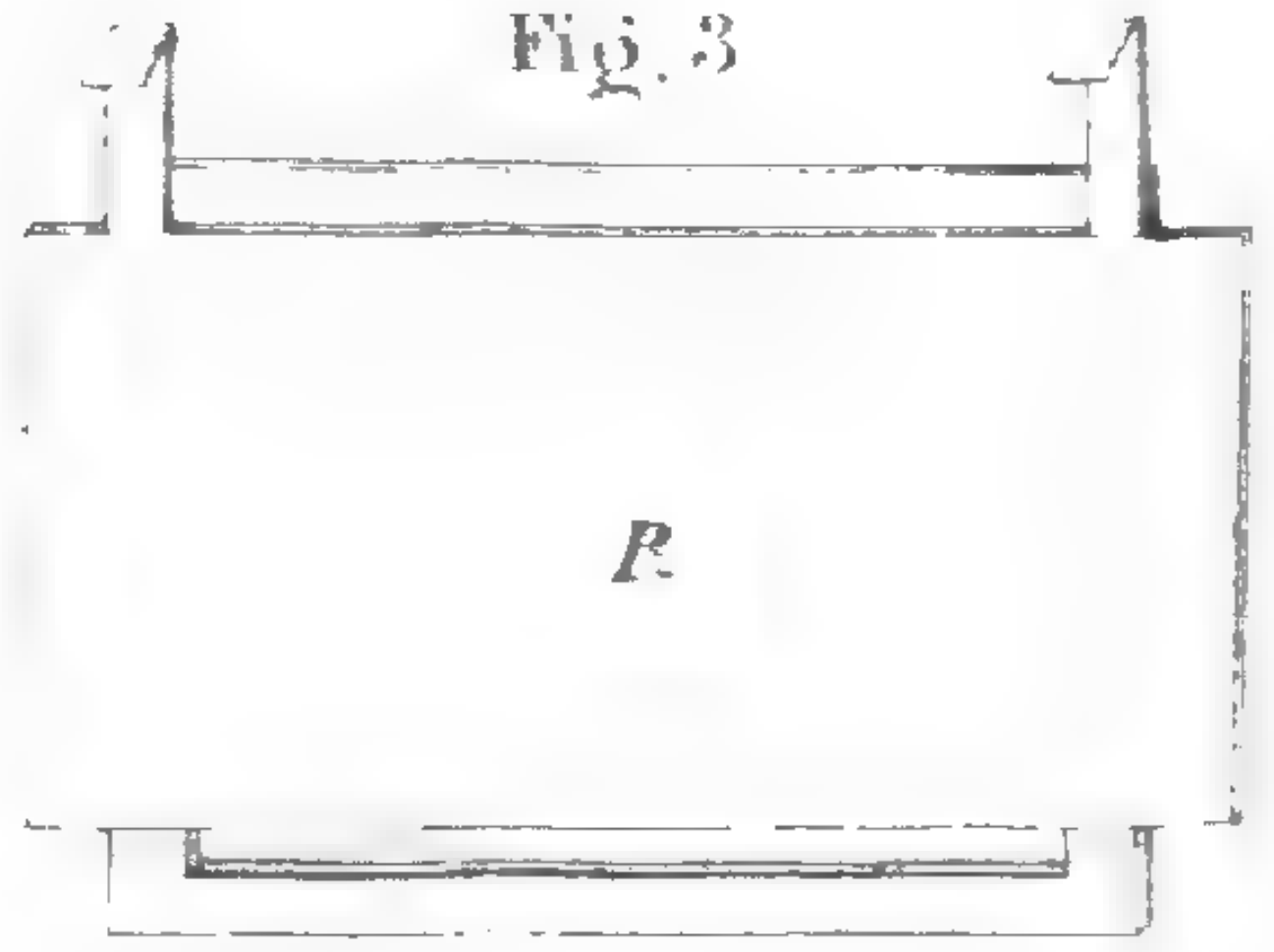


Fig. 6

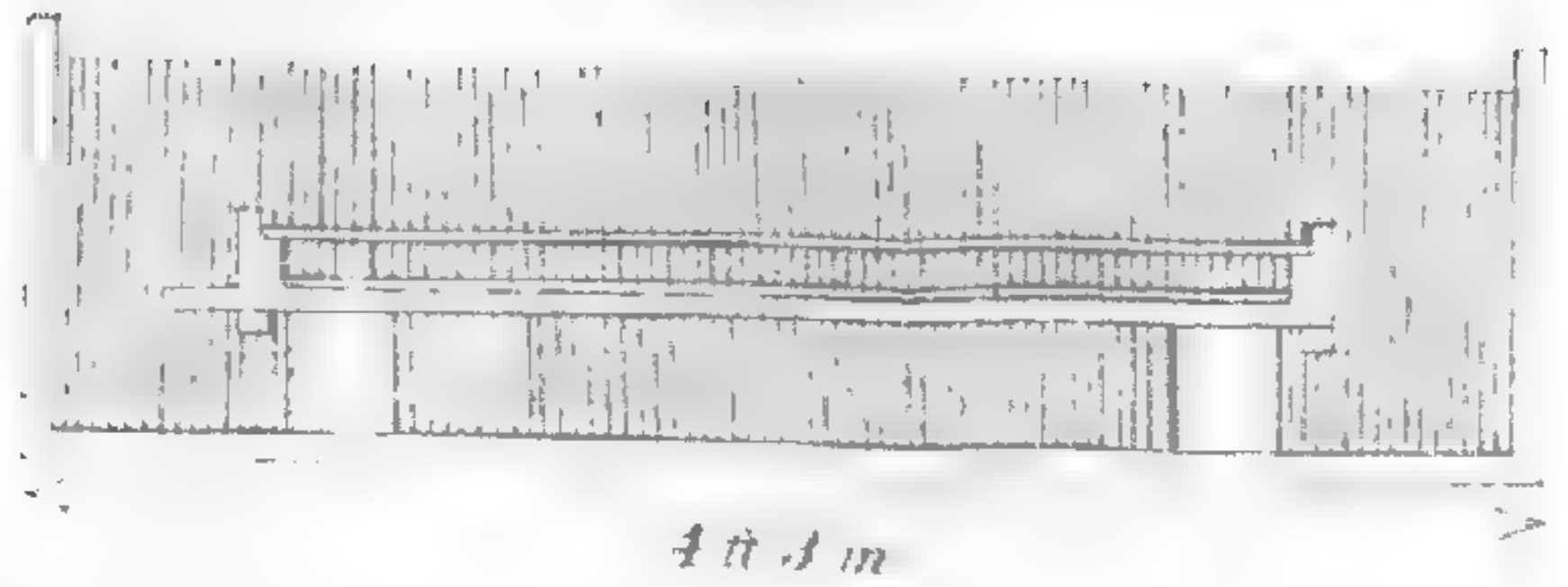
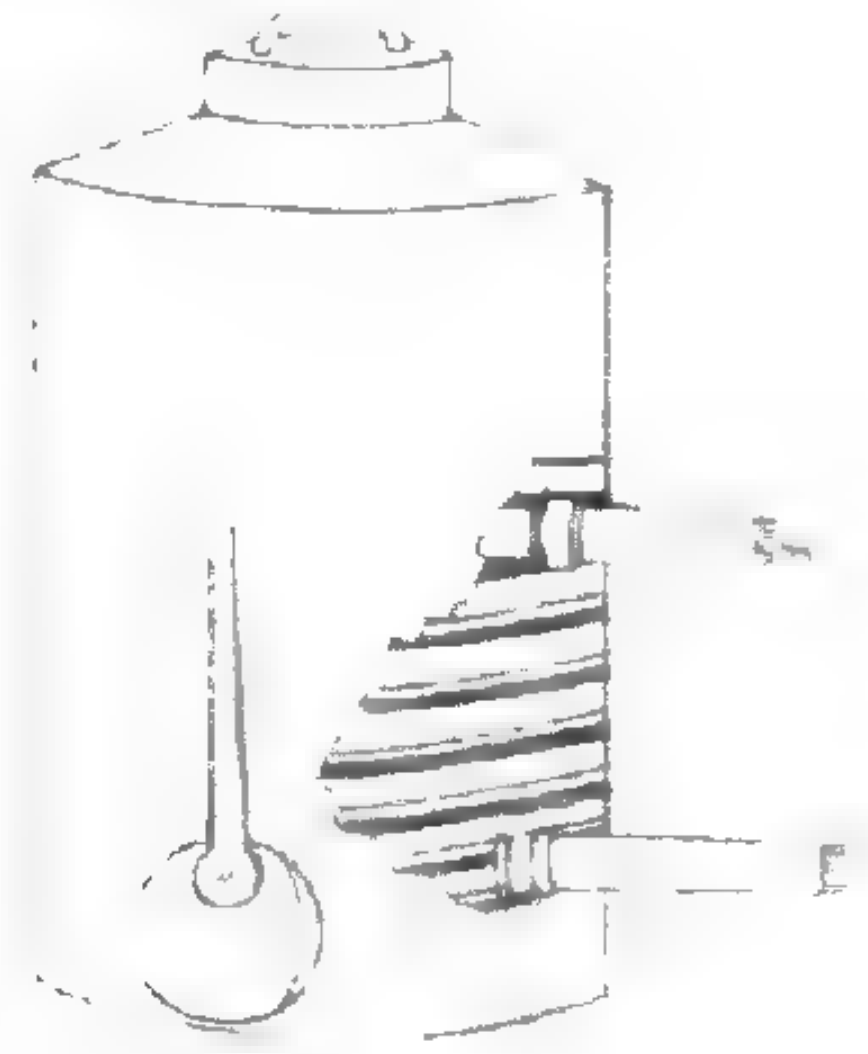
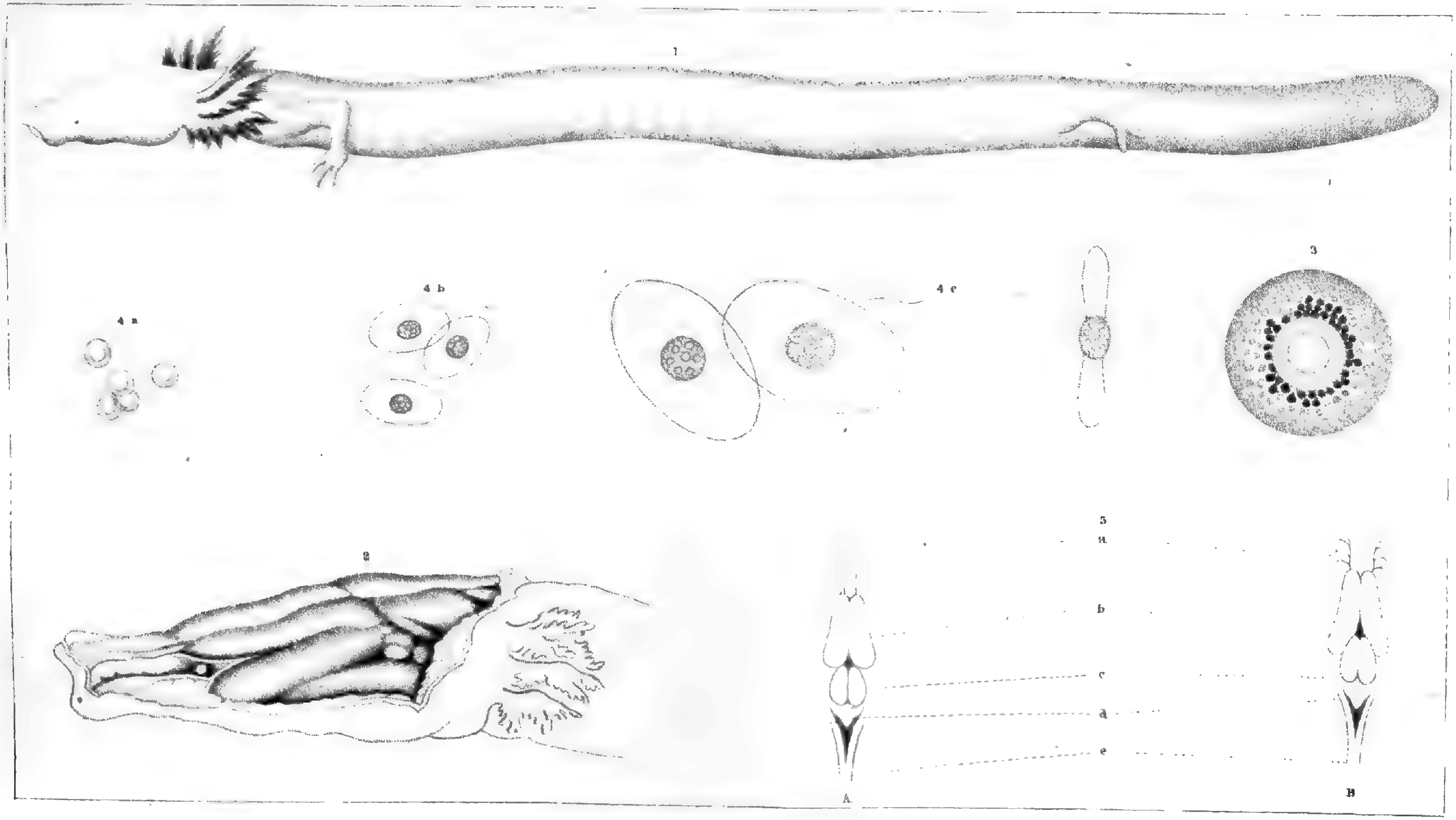


Fig. 7



Amer. Jour. Sci. Vol. XV Plate III.



PROTEUS ANGUINUS

DEPARTMENT OF PHILOSOPHY AND THE ARTS IN YALE COLLEGE.

SCHOOL OF CHEMISTRY AND NATURAL SCIENCE.

JOHN A. PORTER,

Acting Professor of Agricultural and Analytical Chemistry.

W. J. CRAW,

Assistant.

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P. 325, line 11 from top, for "*northeastern*," read "*northwestern*."
P. 358, line 11 from bottom, for "And in another *place*," read "And in another *work*."
P. 358, line 18 from bottom, for "In one of his *desultory volumes*," read "*In his Music of Nature*."
P. 433, line 4 from top, for "*Sanadin*," read "*Sanidin*."
In part of edition, P. 440, 4th line from bottom, for "*ibid*," read "J. f. pr. Ch., lvii, 276."
Vol. xiv, p. 62, line 20 from bottom, for "M: T," read "M or T."

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