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2. Every communication to the Society, which may be considered as intended for a place in the Transactions, shall immediately be referred to a committee to consider and report thereon.

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TRANSACTIONS

OF

THE AMERICAN PHILOSOPHICAL SOCIETY.

ARTICLE I.

On the Diurnal Variation of the Horizontal Needle. By Alexander Dallas Bache, Professor of Natural Philosophy and Chemistry in the University of Pennsylvania. Read November 16, 1832.

During the month of August, and part of September, of this year, the usual summer vacation of the University permitted my absence from the city, and finding myself favourably situated for meteorological observations, I undertook to observe the diurnal fluctuation of the barometer and thermometer, and, ultimately, the hourly variation of the horizontal needle. It was a source of great regret to me, that, in these latter observations, I was not also furnished with a dipping needle, or with the means of directly measuring the variation of magnetic intensity: the observations could all have been accomplished with little more inconvenience than the hourly observations of the horizontal needle gave; and the last named subject is more interesting than the point which I was enabled to observe. This being the case, I had determined not to make public these observations, but to use the experience obtained when occasion might offer an opportunity of prosecuting more extended researches. This resolution has given way to the consideration, that magnetic phenomena have not yet been observed with that closeness of scrutiny to which other branches of experimental science have been subjected; that the inconvenience of hourly observations by day and *by night* have prevented many from entering this particular field; and, finally, that my observations appear to warrant interesting deductions not afforded by the printed observations which I have been able to examine.

It would be out of place, in a brief essay like the present, to attempt a sketch of the observations, either systematic or casual, made upon the diurnal variation of the needle; the references which will be made to other experiments, for the purpose of a comparison of results, will supply the place of such an outline. In making such comparisons, it is hardly necessary to observe, that I disclaim any intention of claiming for my results any more weight than is due to careful and frequent observation during the time for which they were obtained.

In the following account, I purpose, first, to give a description of the instrument, and of its location, and of the mode of observing; next, to present the observations; and, lastly, the conclusions which they may warrant.

The needle was thirty-six inches long, .04 of an inch thick, broader, in its horizontal section, at the middle than at the two ends: it was supported by a steel pivot playing into a ruby cap, and was contained in a prismatic box of mahogany, covered by sliding plates of glass. The weight of the needle was three hundred and fifty-five grains. Attached to each end of the box was a brass arc, divided into degrees and tenths. The zero of each arc, and the pivot on which the needle rested, were in the same line; but the point in the ruby cap, upon which the needle rested, was found to be out of the line joining the two ends. On which account, as well as to render the observations more accurate, two readings were always made: one on the scale near the north pole, the other on that near the south pole of the needle. The nature of the suspension of this needle, though sufficiently delicate for the purposes immediately in view, did not warrant my using its oscillations to obtain the intensity; its shape and length rendering it, besides, un-suitable to such observations, and inducing the fear that it might be liable to changes of magnetism, which would have been fatal to such results.

The relative amount of variation being the object sought, it was only necessary that the needle box should remain in a fixed position during the observations. Wishing, however, further to determine the mean variation of the place of observation, I employed, for tracing a meridian line, the best means which were at hand; namely, equal altitudes of the sun before and after noon, as shown by the passage of the bright image of a circular opening in a metallic plate attached to a style, over a horizontal circle, the centre of which corresponded with the vertical passing through the middle of the opening. This method is well known, and needs no particular description here; the platform used was of wood, the top planed and levelled by a spirit level. Only a portion of the form was truly level, and this portion was used in observing the altitudes. Concentric circles were drawn upon the platform, their centre being in the vertical passing through the centre of a round hole in a copper plate attached to a style; the style was fastened to the middle of the south side of the platform. The shadow of the plate first fell upon the edge of the platform at $10\frac{1}{2}$ A.M., and left it at 2 P.M.; nine observations were made of the passage of the centre of the image of the aperture over different circles, from which the meridian line was determined. The points given by seven observations were in the line; and of those given by two others, the farthest departed but one minute and a half from the same line. The limit of the error by this method is small, though much beyond that which other methods would have furnished. I repeat, however, that this error affects only the mean variation, and not the horary variations.

This platform, upon which the needle rested, was supported upon three posts, about six inches high, and firmly planted; to these it was attached by wooden pins: the same kind of pins had been used in the construction of the platform itself. The location of the platform was in a garden, more than forty feet from the house, and fifteen from a small paling which formed the inclosure. The garden was upon the side of a hill, the ground sloping towards a meadow: a hill enclosed this gorge both on the east and west: behind the western hill the sun passed about eighteen minutes before the time of sunset.

The meridian line having been determined, the box containing the needle was placed upon it, the zero line coinciding with the meridian; the points at which the edge of the box was cut by the line were then marked, so that any change of position might be detected. A temporary inclosure of shingles was next placed around and over the platform, to defend both the platform and the needle from the sun and rain.

The labour of prosecuting hourly observations, by night as well as by day, could not well be endured by a single individual for any number of successive days; and mine, though extending through parts of ten days, would have met with more interruptions, but for the intelligent aid afforded by my friend and former pupil, John F. Frazer, who took a share in the labour of watching. It did not take many nights to perceive that the period from 1 A.M. to seven or eight o'clock, did not include any remarkable points; and when circumstances seemed to permit it, I did not continue the observations between those hours.

A few trials enabled me to determine that the space between the tenths on the scale was readily divisible by the eye into fourths, with accuracy as to the nearest quarter, both by my assistant and myself: the observed variation was therefore thus registered, and the limit of accuracy of one reading was one minute and a quarter. The observations have been turned into minutes and decimals of a minute. To show the errors of reading, no better test can be had than to compare the differences of two readings of both the north and south pole, when either one was at or near the same position. As the most unfavourable specimen of such readings, may be taken the time of the first twenty-four hours, when the observers were the least practised: such a specimen is given in the first table, and it is to be understood that the observations of subsequent days presented much smaller errors of observation, than the average of those there recorded. The observations were begun a few hours before noon, and each table comprehends twelve hours of two successive days.

The temperature of the air was noted at the same time with the variation; the place of the thermometer was in the shade near the house, unless when specially noted to give the temperature of the needle itself. I regretted not having at command instruments to notice both these points at the same time; as the case was, I endeavoured to vary the observations, so as to procure, by separate observation, the same results as far as practicable. The character of the weather, the prevailing clouds, &c., were noted in the column of remarks. Observations were made also upon the barometer and dew point, which I may make the subject of a separate communication to the society.

In the table, under the column for the hour, M. is used to signify noon, and m. midnight. The days of the month are in the column of remarks.

TABLE I.

Hour. Mean time.	Variation. N. Pole W.	Variation. S. Pole E.	Differences.	Mean. N. Pole W.	Temp. Fah.	State of the Weather and Remarks.
	Deg. Min.	Deg. Min.		Deg. Min.	Deg.	
12 M.	3 29.6	3 25.7	3.9	3 27.6	74½	Aug. 29th. Cumulus. Moon near first quarter.
1 P.M.	3 28.3	3 25.0	3.3	3 26.6	76½	
2 P.M.	3 25.1	3 24.2	0.9	3 24.6	78⅛	
3 P.M.	3 23.5	3 21.8	1.7	3 22.6	78⅛	Cumulus. Clear before sun.
4½ P.M.	3 22.6	3 21.8	0.8	3 22.2		Sun striking on end of needle. Further covering added.
5½ P.M.	3 21.8	3 21.0	0.8	3 21.4	76	
6½ P.M.	3 20.2	3 17.3	2.9	3 18.7		Sun sets at 6 h. 33 m.
7 P.M.	3 20.2	3 17.3	2.9	3 18.7	74¾	Clear.
8 P.M.	3 22.6	3 21.8	0.8	3 22.2	71	Clear.
9 P.M.	3 28.3	3 27.2	1.1	3 27.7		Clear.
10 P.M.	3 27.5	3 26.4	1.1	3 26.9	69⅛	Clear.
11 P.M.	3 27.5	3 26.4	1.1	3 26.9	68¼	Clear.
12 m.	3 28.3	3 27.2	1.1	3 27.7	66⅞	Clear.
1 A.M.	3 28.3	3 27.2	1.1	3 27.7	66¼	Clear. Aug. 30th.
2 A.M.	3 26.7	3 25.7	1.0	3 26.2		Clear. Needle vibrating. Observation not good.
3 A.M.	3 23.5	3 22.6	0.9	3 23.0	66½	Hazy.
4 A.M.	3 21.0	3 20.3	0.7	3 20.6	66¼	Clear.
5 A.M.	3 21.0	3 20.3	0.7	3 20.6	66¼	Dense fog.
5½ A.M.	3 21.0	3 20.3	0.7	3 20.6	66¼	Dense fog. Time of sunrise.
6 A.M.	3 21.8	3 21.0	0.8	3 21.4	66	Fog less dense.
7½ A.M.	3 21.8	3 21.0	0.8	3 21.4	67¼	Foggy.
8½ A.M.	3 20.2	3 19.6	0.6	3 19.9		Foggy.
9 A.M.	3 21.0	3 18.9	2.1	3 19.9	70¾	Fog clearing off.
10 A.M.	3 25.9	3 24.2	1.7	3 25.0	72	Cumulus. Sun out. Fog gone.
11 A.M.	3 25.9	3 25.0	0.9	3 25.4	77½	Cumulus.
12 M.	3 27.5	3 25.0	2.5	3 26.2	78½	Cumulus.

The greatest difference of the numbers of the second and third column in the foregoing table is at the beginning, as might have been expected, where it amounts to nearly four minutes, and shows that the first two observations are of little value; the greatest subsequent variation from the mean difference is about one minute and a half.

To have a perspicuous view of the results of the observations for every twenty-four hours, I traced, at the close of each series, a curve, the ordinates of which represented the variation, and the equidistant abscissæ the hours. By writing, at the side of each ordinate, the remarks on the weather, the view was rendered more complete. To compare the progress of the variation with that of the temperature, a curve was traced below the former, in which the ordinates represented the temperatures. The crude observations suggested by the visible representation of the day's results, given in chart No. 1, (see Plate I.*) are not here added; it may not be amiss, however, to state, that my object at this time in tracing the curve of temperature, as well as that of variation, was to ascertain whether the directive force underwent correlative changes with the temperature, as the intensities were supposed to do by M. Kupffer from his first experiments.*

Two maxima of westerly variation, and two minima were distinctly seen in this day's results. The first maximum was at noon day; the second between midnight and 1 A.M. The first minimum was between 6½ and 7 in the afternoon, and the second between 8½ and 9 in the morning. There is, on the contrary, but one tide of temperature, rising until between 2 and 3 in the afternoon, descending with variable rapidity until 6 in the morning, half an hour after sunrise. The descent of the curve is interrupted by the fog, and it was not unnatural to suppose this to have its effect on the hour of the minimum. The hour of evening minimum variation differs, it will be observed, from that obtained by Canton and Gilpin, suggesting a close attention to the results furnished by the subsequent observations.

In the following tables the mean of the observed variations shown by the north and south pole of the needle is given. The hours from

* Recherches sur les Variations de la durée Moyenne des oscillations horizontales de l'aiguille aimenté, &c. A. T. Kupffer, Annales de Chim. et de Phys. vol. 35 (1827).

noon to midnight of the 30th of August are in one column; and in the parallel column, those from midnight to noon of the 31st.

TABLE II.

Hour.	Variation. N. Pole W.	Temp.	Remarks.	Hour.	Variation. N. Pole W.	Temp.	Remarks.
	Deg. Min.	Deg.			Deg. Min.	Deg.	
12 M.	3 26.2	78½	Aug. 30. Clear.	12 m.	3 26.9	71⅜	Aug. 31. Fog.
1 P.M.	3 25.8	80⅜	Sun under cloud. Sky generally clear.	1 A.M.	3 25.4	70¾	Fog. Thermom. hung near needle box. Temp. the same as before removal.
2 P.M.	3 25.8	79¼	Clear.	2 A.M.	3 23.8	71¾	
3 P.M.	3 27.0	80	Clear.	3 A.M.	3 22.2	71⅜	
4½ P.M.	3 23.9	81½	Clear.	4 A.M.	3 22.2	71¾	
				5 A.M.	3 21.0	71⅜	
5½ P.M.	3 23.9	79¼	Clear.	5½ A.M.	3 20.3	72¼	Hazy.
				6 A.M.	3 20.7	72½	
6½ P.M.	3 21.9	75⅞	Clear.	6½ A.M.	3 19.9	72	Mist.
7 P.M.	3 19.9	73⅝	Clear.	7½ A.M.	3 18.7	72¾	
8 P.M.	3 26.2	73	Sky cloudless.	8 A.M.	3 19.1		
9 P.M.	3 28.5	71⅜	Sky cloudless.	9 A.M.	3 18.7	77¾	
10 P.M.	3 28.5	70½	Sky cloudless.	10 A.M.	3 19.9	77⅝	Sun gleams out. Therm. removed to house.
11 P.M.	3 26.9	70¾	Stars not visible through fog. Wind variable.	11 A.M.	3 23.8	80⅜	Sun out. Cumulus.
11½ P.M.	3 26.9	71⅜		11½ A.M.			Variation greater than at 11.
12 m.	3 26.9	71⅜		12 M.	3 26.3	81½	Cumulus. Sky generally clear.

The curves in No. 2, Plate I.*, are those of the variation and temperature from the table just given. We see that the general features are the same, but the details vary very much. We may trace the causes of these variations in the curves of temperature, though the knowledge which we possess on the subject of the variation of the needle does not permit us to do so for it. Both days were clear about noon, with flying clouds (cumulus); the second was a day of settled weather succeeding the first, and the maximum temperature was higher; but about noon in No. 2, the sun was frequently obscured by clouds, and the hour of maximum was removed to between 4 and 5 P.M. No. 1 was descending to the sunrise minimum, when the observation at 3 A.M. showed a rise of temperature, and a haze is noted at the same time; No. 2 in like manner is descending to the same minimum, when, at between 10 and 11 P.M., an irregular rise commences, and a fog is noted, varying only in density, until late in the morning: this fog checked more or less completely the powerful radiation from the earth, which was going on before the screen of fog was interposed between the earth and sky.

It is worthy of note, that in No. 1, at the observation preceding the remark "hazy," we find the memorandum, "needle vibrating."

TABLE III.

Hour.	N. Pole W.	Temp.	Remarks.	Hour.	N. Pole W.	Temp.	Remarks.
	Deg. Min.	Deg.			Deg. Min.	Deg.	
12 M.	3 26.3	81½	Aug. 31.				Sept. 1.
1 P.M.	3 25.4	83					
2 P.M.	3 26.5	84⅞	Shower comes up, lasts 4m.; recommences at 2h. 11m. and rains until 2h. 27m.				
2½ P.M.	3 10.7	84⅞	Ceases to rain for an instant, then recommences.				
3 P.M.	3 25.8	82¼	Sun out.				
4 P.M.	3 23.8	85¼	Sun under a cloud.				
5½ P.M.	3 23.2	84¼	Sun under a cloud. Gust to N. of W.				
5⅘ P.M.	3 10.3	79¾	Rain just begun.				
6 P.M.	3 14.3	78½	Heavy part of gust has passed. Thunder to S.E.				
7 P.M.	3 32.0 3 36.8	77¾	Needle vibrating. No rain. Much thunder and lightning.				
8 P.M.	3 32.4	78⅝	Raining steadily. Gust has entirely passed.	8 A.M.	3 23.8	71¾	Clear.
9 P.M.	3 31.7	77¾	Not raining. Cloudy.	9 A.M.	3 18.3	64	Cloudy. Therm. placed in compass box.
10 P.M.	3 32.0	75	Cloudy.	10 A.M.	3 19.1	65	Cumulus. Sky generally clear.
11 P.M.	3 26.5	75	Raining slightly.	11 A.M.	3 19.9		
12 m.	3 26.2	71	Perfectly clear. Wind N. W.	12 M.	3 20.4	67	Approximate, calculated from that at 12¼ P.M.

The meteorological phenomena of this day were particularly interesting, and will be referred to in detail: the curves of observations are on No. 3, Plate I.* The variation evidently diminishing at midnight, and the sky being clear, the observations were intermitted until 8 A.M. Great pains were bestowed in noting the fluctuations before, during, and after the shower and the gust in the afternoon; the periods of change being seized for observation.

TABLE IV.

Hour.	N. Pole W.	Temp.	Remarks.	Hour.	N. Pole W.	Temp.	Remarks.
	Deg. Min.	Deg.	Sept. 1.	12 m.	Deg. Min. 3 34.9	Deg. 58	Sept. 2. Cloudless night.
12½ P.M.	3 21.0	67½	Clear. Therm. on the platform with needle.	12½ A.M.			Cloudless.
1 P.M.				1 A.M.	3 33.2	58	Cloudless.
1½ P.M.	3 21.9	63	Clear.	1½ A.M.			
2 P.M.				2 A.M.	3 32.0	56	Cloudless.
2½ P.M.	3 21.4	70	Stratus to west.	2½ A.M.			
3 P.M.	3 22.2	69¾	Clear.	3 A.M.	3 32.0	48	Cloudless.
4 P.M.				4 A.M.	3 32.0	47	Cloudless.
5 P.M.	3 22.6		Clear.	5 A.M.	3 31.7	46½	Cloudless.
5½ P.M.				5½ A.M.	3 32.0	44	Cloudless.
6 P.M.	3 15.1	69	Clear.	6 A.M.	3 30.8	47	Clear.
6½ P.M.			Sun sets.	6½ A.M.	3 21.9	48	Clear.
7 P.M.	3 14.7	67½	Cloudless.	7 A.M.			
7½ P.M.				7½ A.M.	3 19.1	58	Clear.
8 P.M.	3 16.0	62½	Cloudless. Moon in first quarter.	8 A.M.	3 12.6	61	Clear.
8½ P.M.				8½ A.M.	3 10.6	64	Clear.
9 P.M.	3 28.5		Cloudless.	9 A.M.	3 12.6	66	Clear.
10 P.M.	3 28.9	60	Cloudless.	10 A.M.	3 13.5	72	Clear.
11 P.M.	3 34.9	59½	Moon sets. Cloudless night.	11 A.M.	3 15.1	76	Clear.
				11½ A.M.	3 12.7	76	Clear.

The weather of the first part of this twenty-four hours was slightly affected by the storm of the day before; there was a stratus to the west at 2½ in the afternoon, which, when it disappeared, left a cloudless day, succeeded by a perfectly clear and still night. The thermometer was, throughout the observations, placed in the inclosure containing the platform, and half hourly observations were resorted to about some of the times remarked by former observations as containing maxima or minima of variation.

The curves given by these observations are traced on No. 4, Plate I.* The free radiation of heat during the night from the earth, caused a great depression in the temperature of the air near to it, the sunrise minimum of the thermometer being as low as 44°, the maximum of the day having been $69\frac{3}{4}$°.

TABLE V.

Hour.	N. Pole W.	Temp.	Remarks.	Hour.	N. Pole W.	Temp.	Remarks.
	Deg. Min.	Deg.			Deg. Min.	Deg.	
12 M.	3 18.7	76	Sept. 2. Clear.				Sept. 3.
12½ P.M.	3 19.9	77½	Clear.				
1 P.M.	3 25.4	80½	Clear.				
1½ P.M.	3 25.4	80	Clear.				
2 P.M.	3 25.4	81	Clear.				
2½ P.M.	3 26.9	79½	Clear.				
3 P.M.	3 26.9	79½	Clear.				
3½ P.M.	3 26.9	79½	Clear.				
4 P.M.	3 26.9	79½	Clear.				
5 P.M.	3 25.4	76	Clear.				
6 P.M.	3 23.0	70	Clear.				
6½ P.M.	3 23.0		Sun sets. Sky generally clear. Cirrus and light cumulus.				
7 P.M.	3 25.4	63	Clear.				
8 P.M.	3 29.3	60	Cloudy. Moon wading through dark cirro-cumulus.	8 A.M.	3 26.2	64	Therm. near house. Cloudy. Dark cumulo-stratus.
9 P.M.	3 29.3	58	Cloudy.	9 A.M.	3 21.9	64	Cloudy. Wind N. E.
10 P.M.	3 27.7	58	Clouds more dense.	10 A.M.	3 22.6		Cloudy.
11 P.M.	3 26.2	58	Moon dips behind hill.	11 A.M.	3 23.0	65½	Cloudy.
				12 M.	3 22.6	65½	Raining.

The night maximum having decidedly passed before 11 P.M., the observations were not made after that hour during the night. The curves of variation and temperature are traced on No. 5, Plate II.*

TABLE VI.

Hour.	N. Pole W.	Temp.	Remarks.	Hour.	N. Pole W.	T mp.	Remarks.
	Deg. Min.	Deg.			Deg. Min.	Deg.	
12 M.	3 22.6	65½	Sept. 3. Raining.	12 m.	3 30.1	60½	Sept. 4.
1 P.M.	3 23.0	65½	Rain ceased. Rain recommenced.	1 A.M.	3 29.3	60½	Raining fast. Wind draws more to south.
2 P.M.	3 26.9	66	Not raining. Nimbus high.				
3½ P.M.	3 26.9	64½	Not raining.				
5 P.M.	3 26.2	66					
6 P.M.	3 21.9	65					
6½ P.M.	3 23.4	65					
7½ P.M.	3 24.6	64					
8 P.M.				8 A.M.	3 16.0	64½	Nimbus.
8½ P.M.	3 26.2	63		8½ A.M.			
9½ P.M.	3 24.6	63		9½ A.M.	3 16.8	66½	Drizzle.
10½ P.M.	3 27.7	62	Slightrain. Wind S. E.	10½ A.M.			
11 P.M.				11 A.M.	3 18.3	67½	Slight rain.
12 m.	3 30.1	60½		12 M.	3 21.0	68½	Slight rain. Clouds lighter than at last observation.

This table will be found interesting, as showing the effect of a steady rain upon the variation. The maximum being passed at 1 A.M., the observations were discontinued until 8 in the morning. The results are traced on No. 6, Plate II.* The thermometer was not in the needle inclosure, but in a fair exposure on the outside of the house.

TABLE VII.

Hour.	N. Pole W.	Temp.	Remarks.	Hour.	N. Pole W.	Temp.	Remarks.
	Deg. Min.	Deg.			Deg. Min.	Deg.	
12 M.	3 21.0	68½	Sept. 4. Gentle rain.	12 m.	3 26.9	69	Sept. 5. Fog less dense. Wind N. of W.
1 P.M.	3 21.4	69½	Not raining. Nimbus.	1 A.M.	3 26.2	68	Needle vibrating slightly. Fog more dense. Air almost still.
2 P.M.							
2½ P.M.	3 21.8	71½	Sun gleams out. Nimbus. Cumulus. Wind S.W.				
4 P.M.	3 25.8	74	Cumulus. Cumulo-stratus.				
5 P.M.	3 25.8	73½	Cumulus.				
6 P.M.	3 24.6		Cumulus. Sun sets in clouds.				
7 P.M.	3 25.8	68	Clear. Cumulus scattered.				
8 P.M.	3 25.8	68	Clear. Fog collecting in valley.	8 A.M.	3 24.9	62½	Needle vibrating. Cloudless. Wind N. W.
9 P.M.	3 26.6	68	Fog in valley.	9 A.M.	3 20.3	63	Clear generally. Cumulus.
10 P.M.	3 26.6	68	Fog dense. Moon obscured.	10 A.M.	3 22.2	64	Clear generally.
11 P.M.	3 26.2	68	Dense fog. Wind hauling to W.	11 A.M.	3 24.3	64½	Clear generally.
12 m.	3 26.9	69	Fog less dense. Wind N. of W.	12 M.	3 24.6	65½	Scattered cumulus.

The weather was very unsettled during these twenty-four hours; there was a rain, then the sky cleared; a fog, which occupied the former part of the night, was dispersed before 8 o'clock in the evening. The wind, at first S. E., shifted to S. W., gradually drew more to the W. and N., and finally settled at N. W. The thermometer was observed on the outside of the house. The curves of variation and temperature are traced on No. 7, Plate II.*

The weather now became settled, and the observations for every hour are given in the following table.

TABLE VIII.

Hour.	N. Pole W.	Temp.	Remarks.	Hour.	N. Pole W.	Temp.	Remarks.
	Deg. Min.	Deg.			Deg. Min.	Deg.	
12 M.	3 24.6	65½	Sept. 5. Scattered Cumulus. Wind N.W.	12 m.	3 34.9	54	Sept. 6. Clear.
1 P.M.	3 25.5	66	Ditto.	1 A.M.	3 30.1	53	Clear. Moon (in 2d quarter) sets.
2 P.M.	3 25.8	66½	Ditto.	2 A.M.	3 31.7	52½	
3 P.M.	3 25.8	67½	Ditto.	3 A.M.	3 32.8	45½	Cloudless. Therm. in inclosure with needle box.
4 P.M.	3 26.5	68	Ditto.	4 A.M.	3 32.8	44½	
4¾ P.M.	3 26.2	67½	Ditto.	5 A.M.	3 31.7	44	
$6\frac{1}{12}$ P.M.	3 21.0	64	Wind has lulled. Sun behind hill.	6 A.M.	3 30.5	47½	
7 P.M.	3 19.9	63½		7 A.M.	3 21.7	55	
8 P.M.	3 25.8	60½	Cloudless.	8 A.M.	3 21.4	62	Therm. removed to house, where it stood at 59½.
8½ P.M.				8½ A.M.	3 22.2		
9 P.M.	3 26.2	57	Cloudless.	9 A.M.	3 21.0	60½	Slight haze (stratus).
10 P.M.	3 26.2	57	Cloudless.	10 A.M.	3 21.7	62	Ditto.
11 P.M.	3 32.1	55½	Scattered cumulus to S.	11 A.M.		63	
12 m.	3 34.9	54	Clear.	12 M.	3 22.2	64	Stratus. Cumulus. Wind W.

From 3 until 8 A.M. the thermometer was in the inclosure with the needle. On its removal to the house, it fell 2½° below its temperature at the former station.

These curves are given in No. 8, Plate II.*

The afternoon of September 6th was clear, with occasional cirrus and collecting cumulus; dew was deposited immediately at sun set, and a dense fog occupied a part of the morning of the 7th. It was proposed to make at least one day's observations with the needle exposed to the direct action of the sun, and by mistake the covering was removed before twelve o'clock on the 7th, as will be seen by the remark in the subjoined table. The curve (No. 9, Plate III.*) representing the observations of this day, terminates at the observation for 9½ A.M.

TABLE IX.

Hour.	N. Pole W.	Temp.	Remarks.	Hour.	N. Pole W.	Temp.	Remarks.
	Deg. Min.	Deg.			Deg. Min.	Deg.	
12 M.	3 22.2	64	Sept. 6. Stratus. Cumulus. Wind W.	12 m.	3 26.6	54	Sept. 7.
1 P.M.	3 22.6	65		1 A.M.	3 26.2	53	
2 P.M.	3 22.6	66					
3 P.M.	3 22.6	67					
4 P.M.	3 22.6						
5¾ P.M.	3 21.0	67	Dark cumulo-stratus to W.	5½ A.M.	3 24.1	54	Low stratus driving fr. E. High cumulus fr. S.W.
6 P.M.	3 21.4	64½	Cirrus.				
6½ P.M.	3 23.0	62¾	Dew deposited at sunset.				
7½ P.M.	3 23.0	58	Cirrus. Rare Cumulus.				
8 P.M.				8 A.M.	3 22.2	60	Dense fog.
9 P.M.	3 26.6	54	Cloudless.	9 A.M.	3 23.3	64	Fog has disappeared.
9½ P.M.				9½ A.M.	3 23.5		Clear. Cumulus sometimes over sun.
9¾ P.M.				9¾ A.M.	2 57.8		Roof removed, variation diminished rapidly, and at 9¾ had increased again to 2 57.8.
10 P.M.	3 26.6	54		10 A.M.	2 58.2	66½	
11 P.M.	3 26.6	52	Very slight haze.	11 A.M.	3 16.0	67	
12 m.	3 26.6	54	Cumulo-stratus to W. Wind drawing to S. of W.	12 M.	3 33.2	69	Vibrating.

On the removal of the covering from the needle, much water was evaporated from the bottom and sides of the box, collecting in drops on the glass at the N. and S. ends of the box; this was wiped off as it collected, by removing the glass. The sudden diminution of variation, and its rapid increase, are points worthy of remark.

The remaining observations were made with the sun upon the needle, a thermometer being inclosed in the box so as to have, hourly, the temperature of the needle. A day intervened between the last observations and those in the table which follows; during that day the box became thoroughly dry, and at night the needle was covered over to prevent a reduction of temperature which would have produced a deposit of dew upon it. The effects shown in the following table are therefore due to comparatively sudden variations of temperature.*

The broken lines representing the observations will be found on No. 10, Plate III.*

TABLE X.

Hour.	N. Pole W.	Temp.	Remarks.
	Deg. Min.	Deg.	
7½ A.M.	3 17.5		Sept. 8. Clear. Needle covered.
8½ A.M.	3 06.0		Needle uncovered.
9½ A.M.	3 13.5		Hazy. Cumulus.
10 A.M.	3 22.2	94	Vibrating between 3° 20′.6 and 3° 23′.8. Therm. in needle box.
11 A.M.	3 39.6	104	Scattered cumulus.
12 M.	3 32.2		Vibrating between 3° 38′.3 and 3° 26′.2. Scattered cumulus. Sun occasionally clouded.
1 P.M.	3 38.3	97	Ditto.
2 P.M.	2 59.2	94	
3 P.M.	2 59.2	86	Sun under a cloud.
4 P.M.	2 59.2	82	Cloudy.
6¾ P.M.	2 26.0	67	Sun has set clear.
8 P.M.	2 44.9	60	Cumulus. Cumulo-stratus.
10 P.M.	2 52.0	54	

The first conclusion which I would draw from a review of the entire series of observations is, that *there were, for the time embraced by them, two maxima and two minima of westerly variation, within every twenty-four hours.* This fact is distinctly shown in each of the curves, and will be pointed out particularly by endeavouring to determine the hours of maximum and minimum variation.

This result agrees with that obtained by Mr Canton, from his extended series of observations, and subsequently by Mr Gilpin. Col. Beaufoy, still later (1813 to 1822), had evidence of the occurrence of the same maxima and minima, though he seems not to have been able to fix the time of the evening minimum.

* Very little consideration will serve to show that these effects cannot be ranked with those recorded by Mr Fox in the Philosophical Magazine for October 1833.

The observations of Capt. Parry and Lieut. Foster at Port Bowen, are of the more interest, that, from the peculiarity of their situation, there was but one point of maximum and one of minimum variation during twenty-four hours. These observations were made nearly every hour of the *day and night.* The latitude of Port Bowen is 73° 14′ N., and the variation of the needle 124° W.

As far as the observations of Lieut. Hood, at Fort Enterprize, warrant any conclusion, it is coincident with that just noticed; the point of maximum easterly variation and that of minimum easterly variation are clearly shown in his observations. Fort Enterprize is in latitude 64° 28′ N., and the mean variation is about 36° 24′ E.

The second conclusion which the foregoing observations seem to me to warrant is, that, through the irregularities which they present, there is shown *a general horary variation as the primary phenomenon and the effects of meteorological changes as modifying causes;* often overcoming the diurnal variation, and impressing their own alterations upon the variation of the needle.

To examine the first part of this deduction, I will follow, in their general features, the several curves traced to represent the observations, omitting No. 3 on account of its peculiarities.

1. The variation is at its maximum during the day, at or near the hour of highest temperature. The greatest difference between these times is two hours and a half. But the day maximum seems subject to great changes of position; in one case occurring at noon, in another not until 5 P.M. These deductions are shown in the tabular view which follows.

Number of Curve.	Hour of Maximum Variation.	Hour of Maximum Temp.	General character of the weather.
No. 1.	12 M.	2⅓ P.M.	Nimbus before noon, and clear just before noon.
No. 2.	3 P.M.	4½ P.M.	Clear, with floating clouds.
No. 4.	3 to 5 P.M.	2½ P.M.	Generally clear, follows unsettled weather.
No. 5.	2½ to 4 P.M.	2 P.M.	Clear. Needle stationary from 2½ to 4 P.M. No proper maximum.
No. 6.	2 to 3½ P.M.	2½ to 4 P.M.	Raining in the morning. Weather variable.
No. 7.	4⅓ P.M.	4 P.M.	Cloudy. Weather variable.
No. 8.	4 P.M.	3⅗ P.M.	Clear.
No. 9.	1 to 4 P.M.	4 P.M.	Cloudy. The observation of the needle at 4 P.M. was uncertain.

2. The westerly variation decreases from this variable maximum to a minimum, which is near the hour of sunset. The time of this minimum is included within the narrow limits of 5¾ and 7 o'clock.*

Number of Curve.	Hour of Minimum Variation.	Hour of Sunset.	Remarks.
	H. Min.	H. Min.	
No. 1.	6 45 P.M.	6 33 P.M.	Clear in the afternoon and at sunset.
No. 2.	7 00 P.M.	6 32 P.M.	Sun sets clear.
No. 4.	7 00 P.M.	6 29 P.M.	Sun sets clear.
No. 5.	6 20 P.M.	6 28 P.M.	Cirrus.
No. 6.	6 00 P.M.	6 27 P.M.	Cloudy. Weather variable.
No. 7.	6 00 P.M.	6 26 P.M.	Sun sets in clouds.
No. 8.	6 45 P.M.	6 24 P.M.	Sun sets clear. Sinks below hill at 6h. 5m.
No. 9.	5 45 P.M.	6 23 P.M.	Sun sets in clouds.
No. 10.	7 16 P.M.	6 21 P.M.	Sun sets clear. The hour of minimum is calculated, the observations show that it was after 6¾h.

3. The variation increases from the minimum just determined to a variable maximum which is reached at or about midnight. On the nights when the weather was not variable, this appears, from the following table, to be true.

Number of Curve.	Hour of Maximum Variation.	Remarks.
	H. Min.	
No. 1.	12 40 A.M.	Clear.
No. 2.	9 25 P.M.	Succeeded by a fog.
No. 4.	11 10 P.M.	Clear.
No. 5.	8 15 P.M.	Cloudy. Clouds increase in density after this hour.
No. 6.	12 00 m.	Raining before and after this hour.
No. 7.	12 00 m.	Fog.
No. 8.	11 40 P.M.	Clear.
No. 9.		Stationary from 9 until 12.

4. From this maximum there is a descent, more or less irregular, to a morning minimum, between 8 and 9 o'clock,

* This places the evening minimum at a much earlier hour than that given by other observers, and from results which I have obtained since, in the city of Philadelphia, I am inclined to suppose it to have resulted from some peculiarity in the locality or season.

Number of Curve.	Hour of minimum westerly variation.	Remarks.
	H. Min.	
No. 1.	8 52	Fog clearing away.
No. 2.	9 00	Fog not breaking until near ten.
No. 3.	9 00	Cloudy.
No. 4.	{ 8 30 8 02	{ Clear. The curve seems to indicate that the true minimum was earlier than 8 h. 30 m. or at 8 h. 2 m.
No. 5.	9 00	Cloudy.
No. 6.	8 00	{ Nimbus. There is a doubt if the true minimum was observed.
No. 7.	9 00	Cloudless.
No. 8.	9 00	Slight haziness.
No. 9.	8 00	Dense fog, which entirely disappeared before 9 o'clock.

It cannot be affirmed that this minimum was not placed at this particular hour, by the effect of the weather, for there are but two observations when the weather was clear, and but three when it was steady, in one of which (No. 6) the minimum may have occurred before any observation was made. It agrees, however, with the recorded observations of others. The observed minima did not depart in any two observations more than one hour from each other.

In order to determine these points still more unexceptionably, and with the further view of observing the effect of meteorological causes, I have taken the mean of the results of eight of the days of observation, including No. 3, for each hour. They are given in the following table ; and curve No. 11, Plate III.* is traced from them. The last column of the table shows the number of observations from which each mean has been deduced, giving, therefore, the relative authority of each.

When the observations were made at the half hours, the mean of half an hour before and half an hour after was taken, as the number for the variation or temperature at the hour. A similar calculation was made for the variation at any particular hour, when no observation had been made, whenever the interval between two observations did not exceed an hour and a half. The mean temperature of the day having varied considerably in the changes of weather, it was thought more correct to enter into the columns of temperature, at the several hours on which observations were not made, an average of the next preceding and succeeding observation, whenever the intervals were considerable. After making this correction, the daily maximum appears to be nearly at the hour on which it occured in clear weather.

Table of Mean Variation and Temperature from noon of August 29th to noon of September 7th, 1832.

Hour.	N. Pole W.	No. of Obs.	Temp. Fahr.	No. of Obs.	Hour.	N. Pole W.	No. of Obs.	Temp. Fahr.	No. of Obs.
	Deg. Min.		Deg.			Deg. Min.		Deg.	
12 M.	3 23.3	9	71.2	9	12 m.	3 29.3	8	63.0	8
1 P.M.	3 24.1	9	72.6	9	1 A.M.	3 28.3	7	61.6	7
2 P.M.	3 24.5	9	73.5	9	2 A.M.	3 28.4	4	60.1	3
3 P.M.	3 24.9	9	73.5	7	3 A.M.	3 27.5	4	57.8	4
4 P.M.	3 24.7	9	74.0	6	4 A.M.	3 26.9	4	57.4	4
5 P.M.	3 24.4	8	73.5	6	5 A.M.	3 26.2	4	57.0	4
6 P.M.	3 20.5	9	70.5	8	6 A.M.	3 25.1	4	58.3	4
7 P.M.	3 22.8	9	68.7	9	7 A.M.	3 20.7	4	63.3	4
8 P.M.	3 25.4	9	66.3	9	8 A.M.	3 20.7	9	65.4	8
9 P.M.	3 27.8	9	64.5	7	9 A.M.	3 19.2	9	66.2	9
10 P.M.	3 27.8	9	63.7	9	10 A.M.	3 20.2	8	67.9	7
11 P.M.	3 28.3	9	63.2	9	11 A.M.	3 21.4	7	67.7	8

The two tides of variation appear distinctly from the mean results, and with but slight irregularities in their increase or decrease. The day maximum is at 3 P.M. The evening minimum at 7, or with probably more truth, as shown by the dotted lines in No. 11, Plate III.*, at 6 h. 26 m. The night maximum is at midnight. The morning minimum at 9 o'clock.

The mean variation, according to this table, for the place of observation, is 3° 24′.7.

The greatest observed variation 3° 34′.9, and the least 3° 10′.6 including all the curves traced. The first of these is the midnight maximum of No. 8, and the second the morning minimum of No. 4. The latitude of the place, which was about one mile from the village of West Chester, is about 39° 58′, and its longitude about 21 miles west from Philadelphia.

The effect of ordinary meteorological phenomena upon the variation was first noticed, I believe, by Mr Christie, who gives a table illustrative of the effect produced by the occurrence of a rain; he has not, that I am aware, followed up the observation to which I allude. Lieut. Foster infers that ordinary meteorological phenomena do not affect the variation of the needle; a result which the different nature of the instruments used or the localities of observation may perhaps be found to explain. In regard to the latter point, there was of course a marked difference in the nature of the meteorological phenomena at the two places. In the whole of the abstract of the meteorological observations given by Lieut. Foster, there is no record of rain, and no notice of thunder storms, while my results, obtained during part of the last month of summer and of the first of autumn, were diversified by steady rains, showers, fogs, &c.

In showing the effects of meteorological phenomena on the variation, I purpose to appeal to the direct evidence afforded by curve No. 3 (Plate I.*); the peculiarities of the other curves may afford collateral testimony, but comparatively of less value. The morning of August 31st was clear with flying white clouds; towards two o'clock a dark cloud came up from the westward and a shower fell; this was not accompanied by thunder or lightning, and soon passed over. Just at the beginning of this shower the variation was 3° 26′.5 W., and as soon as it had ceased, the needle was again observed and was found but 3° 10′.7 W. In saying that there was no extraordinary electrical excitement during this shower, I do not mean to assert that the changes of the variation were not due to the usual electrical changes which always attend such phenomena. Being unprovided with means of estimating electrical changes, I only refer to the visible indications of lightning. The sun now shone out, and at 3 P.M. the variation had increased to 3° 25′.8. Towards 4 P.M. clouds began to gather, and at 5 h. 20 m. black clouds to the N. W. indicated an approaching gust. At the moment the rain commenced the needle was noted, the variation had decreased, between 5 h. 30 m., the time of the last observation, and 5 h. 48 m., 13 minutes. The rain was violent, accompanied by thunder and lightning. At 7 P.M. the rain had ceased, and the gust had passed to the eastward, the needle vibrated violently between 3° 32′ W. and 3° 37′ W. Such irregularities are conclusive as to the influence of the phenomena attending a shower and a gust. The variations noticed will be seen, from curve No. 3, to precede the effects produced on the thermometer; after a general coincidence, the curves depart from each other, the curve of variation rising abruptly, and that of temperature but slightly.

The ill sustained nightly maximum of No. 2 was accompanied by a fog; so was the variable nightly part of curve No. 7, where a fog began to collect at eight in the evening. The nightly rise of curves No. 5 and No. 9, ceased with the coming up of clouds and of haze. The well sustained height of No. 2 was during a clear night, as was the case with No. 4.

The steady rain of Sept. 3d and 4th, does not seem materially to have affected the regularity of the curve.

In conclusion, I would make two brief remarks. The first relates to the observation of two tides of variation while there is but one of temperature. This would seem to be adverse to the supposed influence of heat were it not that we find the same agent producing two fluctuations of the barometer; when we shall be as well acquainted with the effects of local and of general variation of temperature upon the magnet, as we are of its effects upon atmospheric air, the question will be near to its solution.

The second remark relates to the effect of the electrical changes in the atmosphere, or of changes of temperature upon the needle; the meteorological phenomena noticed to affect the variation, probably act through, if they are not produced by one or both of these changes. The experiments of Cavallo have shown, at least with regard to the parts of the atmosphere not very far from the earth's surface, that there is perpetual electrical excitement, and frequent change. If his experiments had led to any conclusions other than the most general, they might perhaps have thrown light upon our subject. Where so much yet remains to be known, even the imperfect labour here presented may not be without its fruits.

ARTICLE II.

Observations on the Naïades; and Descriptions of New Species of that, and other Families. By Isaac Lea. Read before the American Philosophical Society March 16, 1832.

PRELIMINARY REMARKS.

In presenting myself again before the Society with a new memoir in that department of conchology which has so much engaged my attention for some years, an apology would seem almost necessary. My zeal and love for the science generally will, I trust, be sufficient for my present intrusion on its time.

The family *Naïades* seems to have excited very little interest with the older writers on natural history, and not much more among modern zoologists until within the present century.

The progress of general knowledge, and the improvements in the mechanic arts, have recently been greatly accelerated, and the discoveries and improvements in the study of natural science, have gone on "pari passu" with them; and we have every reason to believe that the momentum which they have acquired will not be diminished, for, to use the words of one of the most successful writers of the present day, "there is growing up an enlightened public opinion" which no power is likely to arrest, and which must carry us far towards a perfect state of knowledge, while there is such a "diffusion of existing knowledge among the mass of mankind" as we have at present.

We can only account for the almost total neglect of the family *Naïades* by writers on natural history of the last century, in the fact that the fresh waters of Europe produce so few species that they had then scarcely attracted attention. The habits of these animals have been there so little studied and known, that some recent writers of reputation assert that they move with the beaks of the shell "downward," which is equivalent to saying they walk on their backs. The *anterior* part has been called the *posterior* part, which is as much as to say, that their locomotion is backward.

These facts display a great want of attention to the animal in its element,—where it would be observed to possess many curious and striking characteristics. The great systematist, the immortal Linneus, whose name will be found recorded in the book of the last student of natural history, knew so few members of this family that he classed them indiscriminately with two *marine genera*, *Mya* and *Mytilus.*

It was the rich and splendid productions of the rivers of the United States, and particularly those which are tributary to the Mississippi, which first roused the attention of the zoologist to their extraordinary characters; and they have within a few years become sought after by collectors as eagerly as the "most precious jewels of the ocean."

Urged by the solicitations of numerous scientific friends, I have continued my efforts to obtain such specimens as appeared to me to be new and undescribed, and they are now submitted to the consideration of the Society.

In my communications I have heretofore said little on the geographical position of our *Naïades*. It has, however, been to me an interesting branch of the subject, and engaged much of my attention. The great dividing ridge or chain of mountains, the Alleghanies, which seems so completely to separate our eastern from our western waters, almost as completely separates the species of this family inhabiting those parts lying east and west of it. It is a matter of doubt if there be more than two or three species of all the genera of this family existing in the eastern waters which have their analogues in the western waters. That shell, which we have considered the *Unio cariosus* of the Ohio, certainly has a different aspect from that of our eastern rivers, and might with great propriety be referred to the name which Mr Say gave it long since, viz. *U. crassus.** There is another shell, however, in the Ohio, which has a stronger resemblance than this, and I believe it to be the analogue of the *Alasmodonta marginata* (Say). I have examined numerous specimens of this species frequently and attentively, but cannot distinguish any difference except in the size, the western shell being generally much larger. Of the numerous species and genera of the families *Lymneana*, *Melaniana* and *Peristomiana*, I have never seen a single species common to both waters. To the genus *Cyclas* I have given but little attention, but believe the same observations may be extended to this species.

What an interesting field do these facts spread open to the inquiring philosopher! Why should the streams which flow down the sides of the same range of mountains, east and west, differ so essentially in their productions?

Let us now examine the extremities of this great chain. To the north, where it is lost in the high lands which spread out along the southern boundaries of the small lakes in the state of New York, great difficulty naturally occurs in defining the line of separation. So far as my observation has extended, the shells of the river Mohawk and its tributaries are the same with those of the Delaware, Potomac, &c. with the exception of a single species *Symphynota compressa* (nobis), which is found near Albany, and which exists also in the Ohio. The tributaries of the lakes Erie, Michigan, &c., with few exceptions, produce the western species, and consequently the lakes do also.†

The great river Niagara, or rather strait connecting the lakes Erie and Ontario, furnishes us with the *U. triangularis* (Barnes), and other species, which are so peculiarly characteristic of our western waters. Never having visited the shores of lake Ontario, I cannot pronounce on its productions. The shells of the river St Lawrence are, I believe,

* A shell which I have always considered as a truncated variety of *U. crassus* of the Ohio, has by this naturalist been made a new species under the name of *U. abruptus*.

† Since writing the above I have received the *U. complanatus* (Soland.) from Lac Vaseux, which empties into Green Bay; and more recently the same species from lake Champlain. The *U. nasutus* (Say) has been observed in Grand river, which disembogues into lake Erie.

impressed with the character of those of the lake. In this river there is, however, little to my knowledge interesting to the conchologist.

Lake Champlain, which empties its waters into the St Lawrence, is prolific in some of the western species. The *Symphynota alata*, the *Unio occidens* and the *Unio rectus*, with some other western species, are found there in great perfection, but none of the tuberculated or undulated species.

The southern extremity of the Alleghany ridge is supposed to reach into the upper part of the state of Alabama, where it terminates by spreading out into high lands east of the river Tennessee, and near to that part where the river makes its most eastern angle. The sources of the Alabama and Tombeckbee rivers, which discharge themselves into the Gulf of Mexico, are situated in these high lands, and the character of the shells of these rivers is completely the same with those of the western waters. In no instance have I observed a shell from these rivers, or the Mississippi, which possessed the characters of those of our eastern rivers. To draw the exact line of distinction here, in the present state of our knowledge, is impossible; but that such a line does exist there can scarcely be a doubt.

The great difficulty experienced by naturalists in procuring specimens from newly settled and distant parts of the United States is such, as to deprive us of much desirable information. This impediment will, it is hoped, be overcome in time, and the natural history of our country become universally known.

In the present state of our knowledge, we can only place this line somewhere between the Alabama and the Altamaha rivers. From the latter, I have seen but a single valve, which I owe to the kindness of Mr Nuttall. This is the *U. complanatus* (Soland.), and marks distinctly the character of the shells of this river to appertain to that of the eastern waters. From the river Appalachicola I have never been able to procure a single specimen, and it remains yet to be proved whether it produces shells of the eastern or western character. As, however, it disembogues in the Gulf of Mexico, it is more than probable that it possesses the same species as the western waters, and its neighbour the Alabama.

In regard to the shells of the soil, it will naturally be asked if they also differ so completely as those of the rivers on the two sides of the great ridge? In these the distinction does not exist, for we find almost every species which is common on the eastern, equally common on the western side. There are, however, some species which are not uncommon on the western side, but which do not exist, so far as my information extends, on this side. If it be demanded why the line of demarcation should not be as perfect for terrestrial as fluviatile shells, we might say in answer, that the barrier of a mountain could in time be overcome even by the slowly travelling snail. Surely in the lapse of time the progeny of those which accidentally began to climb the steeps, might descend into the valleys of the opposite side.

In finishing these introductory remarks, I wish to call the attention of those naturalists who are conveniently located, to make further observations on this branch of the science, which certainly has great interest.

In describing the *Valvata arenifera* in my last memoir, Vol. IV. page 104, I was impressed with the idea, from the circumstance of finding a true operculum combined with a spiral tube, that the animal must have belonged to the family *Peristomiana*. I have reason, however, since, to doubt the truth of my conclusions. Professor Troost, now at Nashville, Tennessee, originally sent the specimens from that neighbourhood; and from his description of the animal, which he has recently communicated to me, I am induced to believe it to be a species of Linnean *Phryganía*.

Unio Nicklinianus. Plate I. fig. 1.

Testâ subtrigonâ, inæquilaterali, obliquâ, maxime undulatâ, usque ad natium apices; valvulis crassissimis; dentibus lateralibus crassis curvisque; cardinalibus maxime crassis; margaritâ albâ et iridescente.

Shell subtriangular, inequilateral, oblique, very much undulated, even to the point of the beak; valves very thick; cardinal teeth very thick; lateral teeth thick and curved; nacre pearly white and iridescent.

Hab. China.

My Cabinet.

Diam. 2, Length 5, Breadth 5·8 inches.

Shell subtriangular, oblique, very much spread out, with an elevated wing, flattened towards the beaks, the greatest diameter being near the posterior basal margin, covered with numerous undulations, except on the anterior and basal margins; undulations diverge from the beak, and are largest near the posterior margin: substance of the shell very thick in the region of the basal margin; beaks pointed but not elevated, covered with numerous beautiful literations to the very point; epidermis dark brown; cardinal teeth very large, thick and sulcate; lateral teeth thick and curved; anterior cicatrices rough and distinct; posterior cicatrices slight and confluent; dorsal cicatrices situated on the under side of the cardinal tooth; cavity of the beaks angular; nacre pearly white, very iridescent on the posterior part, where the undulations are visible from without.

Remarks.—I met with this very interesting species in the autumn of 1831 at a dealer's in New York. I was informed that it was supposed to be from China. A single valve only could be obtained, and this unfortunately not entirely perfect. The characters are, however, so distinct from any species I have seen, that I have not hesitated to give it a place among my new species. It is remarkable for its great extent from the top of the wing to the basal margin, and for its numerous undulations. In outline and diameter it resembles the *Symphynota complanata* (nobis) (*Alasmodonta complanata* of Barnes), but differs in being less transverse, higher in the wing, and more thickly covered with undulations. In the possession of many folds, it resembles the *U. multiplicatus* (nobis), but differs in outline (being much less transverse), as well as in the size of the undulations, which are much smaller. The point of its greatest diameter is much nearer the posterior basal margin than in the *multiplicatus.* The imperfect state of this specimen has prevented me from describing the ligament. Judging from its elevated wing, I am much inclined to believe that when perfect specimens are procured they will be found to be connate. If so, it will belong to a natural division removed from *Unio*, viz. *Symphynota.* I have dedicated this fine species to my friend P. H. Nicklin, Esq., of Philadelphia.

Unio capillaris. Plate II. fig. 2.

Testâ suborbiculatâ, ventricosâ, subæquilaterali, postice subangulatâ; valvulis subcrassis; natibus prominentibus; epidermide nitide rugatâ; radiis numerosis capillaribusque; dentibus cardinalibus valde elevatis; lateralibus lamellatis et sursum subreclivis; margaritâ albâ et iridescente.

Shell suborbicular, ventricose, subequilateral, subangular posteriorly; valves rather thick; beaks elevated; epidermis finely wrinkled; rays numerous and capillary; cardinal teeth much elevated; lateral teeth lamellar, and inclined to curve upwards; nacre pearly white and iridescent.

Hab. Ohio. T. G. Lea.

My Cabinet.

Cabinet of the Academy of Natural Sciences of Philadelphia.

Diam 1·2, Length 1·5, Breadth 1·9 inches.

Shell suborbicular, ventricose, subequilateral, subangular posteriorly; substance of the shell rather thick anteriorly; thinner posteriorly; beaks thick and elevated; ligament short and thick; epidermis dark and finely wrinkled, smoother towards the beaks; rays numerous, capillary, and spreading over nearly the whole disk; cardinal teeth elevated, crenate, deeply cleft in the left valve, and rising from a pit in the right; lateral teeth lamellar, crenate, inclined to turn upwards; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices situated on the under side of the cardinal tooth; cavity of the beaks obtusely angular; nacre pearly white and iridescent.

Remarks.—I have had a single specimen of this shell for some years, and although satisfied it differed from any described species, I deferred bringing it forward until I should have an opportunity of examining more. In the fine collection of the Academy of Natural Sciences I found a second specimen, which so completely coincided in all its characters with mine, that I deemed it unnecessary to hesitate erecting it into a species. Both the specimens have that enlargement of the inferior portion of the umbonial slope mentioned in the remarks on the *U. Haysianus* herein described, which usually causes a remarkable and curious denticulation of the margin, and a poverty of the deposition of the nacre in that region. It has, perhaps, a stronger resemblance to *U. ellipsis* (nobis) than to any other species. It is however more rotund, more minutely rayed, and less oblique.

Unio subglobosus. Plate II. fig. 3.

Testâ subglobosâ, subæquilaterali, inflatâ et postice subangulatâ; valvulis crassis; natibus prominulis rotundatisque; dentibus cardinalibus latis striatisque, lateralibus subcurvis; margaritâ subrufâ, vel colore caryophylli tinctâ.

Shell subglobose, nearly equilateral, inflated, subangular behind; valves thick; beaks slightly prominent, rounded; cardinal teeth wide and striated; lateral teeth somewhat curved; nacre pearly and pink coloured.

Hab. Bayou Teche, Louisiana. W. M. Stewart.
My Cabinet.
Cabinet of the Academy of Natural Sciences of Philadelphia.
Cabinet of Mr Stewart.
Cabinet of William Hyde.
Cabinet of P. H. Nicklin.

Diam. 1·6, Length 2·1, Breadth 2·9 inches.

Shell subglobose, subequilateral, subangular behind, inflated; substance of the shell thick; umbonial slope carinate; beaks slightly prominent, rounded; ligament rather short and thick; epidermis dark brown or black; cardinal teeth wide, striate, but not divided; lateral teeth somewhat curved, serrate and separated from the cardinal teeth by the absence of a plate; anterior cicatrices distinct, posterior cicatrices confluent and large; dorsal cicatrices situated across the cavity of the beaks and very distinct; cavity of the beaks large and rounded; nacre pearly and pink coloured.

Remarks.—This very distinct species is one of the many fine shells collected by Mr Stewart in the Bayou Teche. It perhaps most resembles an inflated specimen of *U. cuneatus* (Barnes). It may, however, at once be distinguished from that species by its peculiarly beautiful pinky lustre and striate cardinal teeth, as well by its globosity. The striæ of the cardinal teeth diverge from a point beneath the point of the beaks, and in its flatness and absence of a cleft these teeth resemble those of the *U. rubiginosus* (nobis).

UNIO CAPSÆFORMIS. Plate II. fig. 4.

Testâ ellipticâ, transversâ, inæquilaterali, subinflatâ, postice subtriangulatâ; valvulis antice crassioribus; natibus prominulis; dentibus utriusque valvulæ cardinalibus, elevatis duplicibusque; lateralibus elevatis et lamellatis; margaritâ albâ et iridescente.

Shell elliptical, transverse, inequilateral, somewhat inflated, sub-biangulate posteriorly; valves thicker anteriorly; beaks slightly elevated; cardinal teeth elevated and double in both valves; lateral teeth elevated and lamellar; nacre pearly white and iridescent.

Hab. Cumberland River. W. Cooper.
My Cabinet.
Cabinet of W. Cooper.
Cabinet of the Academy of Natural Sciences of Philadelphia.

Diam. .9, Length 1.3, Breadth 1.9 inches.

Shell elliptical, transverse, inequilateral, somewhat inflated, flattish before the umbonial slope, sub-biangulate posteriorly; substance of the shell thick anteriorly and thin posteriorly; beaks slightly elevated and rounded; ligament short and thick; epidermis yellow, with numerous small green rays; cardinal teeth elevated, double and crested in both valves; lateral teeth elevated and lamellar; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices situated within the cavity of the shell on the plate between the cardinal and lateral teeth and on the base of the cardinal tooth; cavity of the beaks wide and obtusely angulate; nacre white on the anterior and iridescent on the posterior portion.

Remarks.—While engaged in my last memoir, this shell attracted my attention. I had not, however, then, an opportunity of examining more than two or three specimens, and finding they differed much in some characters, I deferred noticing them. I owe to Mr Cooper the advantage of examining his specimens, which convinced me the species was distinct. This is one of those species which sometimes dilate or increase about the region of the umbonial slope, and in this and its rays it resembles, in a slight degree, the *U. perplexus* (nobis). The enlargement of this portion of the shell, which is generally a deep green, causes it to have a different outline, being there more rounded and causing the basal margin to be arcuate.

UNIO RAVENELIANUS. Plate III. fig. 5.

Testâ late ovatâ, obliquâ, inæquilaterali, postice subangulutâ; valvulis antice crassioribus; dentibus cardinalibus crassis brevibusque; lateralibus crassis rectisque; margaritâ albâ et iridescente.

Shell widely ovate, oblique, inequilateral, subangulate posteriorly; valves thicker anteriorly; cardinal teeth short and thick; lateral teeth straight and thick; nacre pearly white and iridescent.

Hab. French Broad River, tributary to the Tennessee, near Asheville, N. C. Professor Ravenel.

My Cabinet.

Cabinet of the Academy of Natural Sciences of Philadelphia.

Cabinet of Professor Ravenel, Charleston, S. C.
Cabinet of P. H. Nicklin.
Cabinet of Professor Vanuxem.

Diam. ·7, Length ·9, Breadth 1·5 inches.

Shell widely ovate, oblique, inequilateral, subangulate posteriorly, slightly inflated, compressed at posterior and inferior margins; substance of the shell thick and white anteriorly, thin and iridescent posteriorly; ligament short and thick; epidermis dark brown and finely wrinkled; cardinal tooth short, thick and deeply divided in the left valve, single and rising from a pit in the right valve; lateral teeth oblique, straight and thick, having a direction over the lateral tooth; anterior and posterior cicatrices both distinct; dorsal cicatrices situated within the cavity of the shell on the plate between the cardinal and lateral teeth; cavity of the beaks shallow and rounded; nacre white in the anterior, and iridescent in the posterior portion.

Remarks.—This shell, which I owe to the kindness of Professor Ravenel, has, I believe, been first noticed by that gentleman, who, supposing it to be new, sent it to me about a year since. It differs in its outline from any of our eastern species, as it does also in its obliquity. In these characters it most resembles the *U. patulus* (nobis); it is, however, more dilated,—in some specimens the margin being subrotund. The only specimens obtained by Professor Ravenel being imperfect, and much eroded at the beaks, I have not described that part, leaving it for future observation. There are no rays to be observed on the specimens I have. In young or fine specimens, it is very possible they may exist.

Unio Murchisonianus. Plate III. fig. 6.

Testâ angulato-ellipticâ, transversâ, inæquilaterali, valvulis tenuiculis; natibus perplicatis; dentibus cardinalibus in valvulâ utrâque duplicibus, lateralibus rectis; margaritâ pulchrâ, iridescente, et salmonis colore subtinctâ.

Shell narrow-elliptical, transverse, inequilateral; valves rather thin; beaks much plicated; cardinal teeth double in both valves; lateral teeth straight; nacre splendidly pearly, slightly salmon coloured, and beautifully iridescent.

Hab. China. Mrs Murchison.

My Cabinet.

Diam. ·7, Length ·8, Breadth 1·9 inches.

Shell narrow-elliptical, transverse, inequilateral, angular behind, and slightly emarginate at basal margin; substance of the shell rather thin; beaks and umbones beautifully plicated; umbonial slope subcarinate and rough with the angles of the folds; posterior slope finely plicate; ligament yellow and narrow; epidermis dark green; cardinal teeth double in both valves; lateral teeth straight; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices in the centre of the cavity of the beaks; cavity of the beaks shallow; nacre rich, and splendidly pearly, slightly salmon coloured, and beautifully iridescent.

Remarks.—This splendid species I owe to the great kindness of Mrs Murchison, the wife of the present learned president of the Geological Society of London. Among many fine and rare shells received from her I found this, which appears not to have been before described. It perhaps most resembles the *U. cœruleus* (nobis), particularly in the outline: it is, however, rather more transverse. It differs greatly from the *cœruleus* in the number and size of the folds. These, behind the umbonial slope, are parallel to the ligament; while those on the anterior margin are oblique. The acute angles formed by the folds on the umbonial slope are very remarkable. The inferior part of the shell is free from folds: this may not, however, prove a constant character. Its nacre is without exception finer than any I have ever seen, and rich beyond description. The folds being visible from the interior, add greatly to its lustre.*

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* Since writing these remarks I have seen several specimens of this shell in Europe. At the Jardin des Plantes, Monsieur de Blainville showed me two or three specimens recently received, and not yet placed in the cabinet. He considered the shell undescribed, until I mentioned the name I had given it.

Unio Haysianus. Plate III. fig. 7.

Testâ subrotundâ, subventricosâ, ad baseos marginem posteriorem dentatâ; valvulis subcrassis; natibus prominentibus; epidermide luteo-fuscâ lævissimaque; radiis obsoletis; dentibus cardinalibus in lobos divisis, lateralibus crassis rectisque; margaritâ cacao colore tinctâ.

Shell subrotund, slightly ventricose, dentate at posterior basal margin; valves scarcely thick; beaks elevated; epidermis yellowish brown and very smooth; rays obsolete; cardinal teeth lobed; lateral teeth thick and straight; nacre chocolate coloured.

Hab. Cumberland River. Professor Troost.
My Cabinet.
Cabinet of Mr Cooper.
Cabinet of Professor Troost, Nashville.

Diam. ·6, Length ·8, Breadth 1 inch.

Shell subrotund, nearly equilateral, slightly ventricose, dentate at posterior margin, depressed before the umbonial slope; substance of the shell scarcely thick; beaks thick and elevated; epidermis yellowish-brown, very smooth and shining; rays obsolete; cardinal teeth lobed, double in the left valve, single and rising from a pit in the right valve; lateral teeth short, thick and straight; posterior and anterior cicatrices both distinct; dorsal cicatrices situated within the cavity of the shell on the plate between the cardinal and lateral teeth; cavity of the beaks deep and angulated; nacre chocolate coloured and iridescent posteriorly.

Remarks.—It has been in my power to examine only four or five specimens of this exceedingly interesting shell. In each of these there is more or less of a dentate appearance, which is so unusual among the *Naïades* that it may, perhaps with propriety, be said to belong to some American species only. In the early stages of growth there is no dentate appearance. The *U. sulcatus* (nobis) and the *U. arcæformis* (nobis), are frequently furnished with this curious appendage. The dentate variety, mentioned in my description of *U. sulcatus*, has been, by Mr Say, erected into a separate species, under the name of *ridibundus;* in the propriety of which, however, I cannot agree with that naturalist. In outline the present species resembles the *U. subrotun-*

dus; it is, however, more oblique, and in the epidermis more shining. It is not so oblique as the *sulcatus*, but has a furrow anterior to the umbonial slope similar to that species. In the epidermis it differs very much, the *sulcatus* being finely wrinkled and finely rayed. In some specimens the successive rows of teeth along the posterior margin cause that portion of the shell to swell out, which gives it a rich and beautiful appearance. It is, though small, among the most interesting of our species. The specimen here represented, I owe to the kindness of Mr Cooper. It is with pleasure I dedicate this species to my friend, Isaac Hays, M.D., whose talents have been actively and successfully engaged many years in the promotion of natural as well as medical science.

Unio Hildrethianus. Plate III. fig. 8.

Testâ angusto-ellipticâ, subcylindraceâ, valde transversâ, inæquilaterali; valvulis tenuibus; dente cardinali in valvulâ utrâque unico, laterali nullo; margaritâ superne fuscâ, inferne albâ et iridescente.

Shell narrow-elliptical, subcylindrical, very transverse, inequilateral; valves thin; cardinal teeth single in each valve; without lateral teeth; nacre, above brown, below white and iridescent.

Hab. Ohio, near Marietta. Dr Hildreth.

My Cabinet.

Cabinet of Dr Hildreth.

Cabinet of the Academy of Natural Sciences.

Diam ·5, Length ·7, Breadth 1·6 inches.

Shell narrow-elliptical, subcylindrical, very transverse, inequilateral, somewhat compressed at basal margin; substance of the shell thin behind, thicker before; beaks slightly elevated; ligament long and thin; epidermis dark brown; cardinal teeth lobed, single in each valve, larger and wider in the left valve; lateral teeth none; anterior and posterior cicatrices both confluent; dorsal cicatrices in the centre of the cavity of the beaks; cavity of the beaks shallow and tinged with dull purple; nacre white and iridescent.

Remarks.—Among the *Uniones* there is a group to which this species naturally belongs. This group is characterized by the imperfection of the hinge, the cardinal teeth being so immature as to present scarcely any thing but lobes. Like the *soleniformis* it lives under stones and other protected places. In the present species the tooth of the right valve shuts before that of the left, and the lateral teeth, if not entirely wanting, are obsolete. The group, as far as I know it at present, consists of the *U. oriens* (nobis), *U. soleniformis* (nobis), and the present species. In size and outline of the margin, this species resembles the *U. iris* (nobis). It has not, however, the brilliant nacre, nor the fine rays of that species, and in the conformation of the teeth it differs very much. Some individuals vary from the cylindrical form, being somewhat compressed. As a mark of respect for the talents of Dr Hildreth, and his assiduity in promoting a knowledge of the natural history of his vicinity, I dedicate this species to him.

Unio Schoolcraftensis. Plate III. fig. 9.

Testâ subrotundatâ, subæquilaterali, compressâ, post clivum umboniale subtuberculatâ; valvulis subcrassis; natibus prominentibus; epidermide fulvâ, latoradiatâ; dentibus cardinalibus prominentibus, lateralibus laminatis rectisque; margaritâ albâ et iridescente.

Shell subrotund, nearly equilateral, compressed, slightly tuberculated behind the umbonial slope; valves rather thick; beaks elevated; epidermis yellow with broad rays; cardinal teeth elevated; lateral teeth straight and lamellar; nacre pearly white and iridescent.

Hab. Fox River of Green Bay. Mr Schoolcraft.

Cabinet of the Academy of Natural Sciences of Philadelphia.

Diam. ·7, Length 1·1, Breadth 1·3 inches.

Shell subrotund, somewhat angular at posterior dorsal margin, nearly equilateral, compressed, slightly tuberculated posterior to umbonial slope; substance of the shell rather thick; beaks elevated; ligament short; epidermis smooth, somewhat yellow, with several broad green rays—that over the centre of the disk being broadest; cardinal teeth elevated and cleft in the left valve, single and rising from a pit in the right; lateral teeth elevated, straight and lamellar; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices within the cavity of the shell on the base of the cardinal tooth; cavity of the beaks angular and deep; nacre pearly white and iridescent.

Remarks.—Among the many fine shells presented to the Academy of Natural Sciences by Mr Schoolcraft from the region of the upper lakes, there was a single specimen of the present species. It does not seem referable to any described species, and I have consequently been induced to give it a separate place in the genus. It resembles most the *U. rubiginosus* (nobis) in outline, but differs from it in being more rounded on the inferior and posterior portions of the margins, as well as in the cardinal tooth being more elevated and more deeply cleft. In the rays it differs very much from that species. In this specimen they are very remarkable, there being a very distinct broad one anterior to the umbonial slope, covering one third of the side of the disk, and two smaller, posterior to the umbonial slope. When there is but a single specimen to describe from, it should be remembered that many characters are not permanent, and I should not be surprised if specimens of this species be found without a single ray, although they are so striking in this. The tubercles, which are so indistinct, may in other specimens be more distinct and more numerous. In this case it will approach so closely to the *asperrimus* (nobis), that it may prove to be only a variety.

Unio geometricus. Plate IV. fig. 10.

Testâ trapezoidali, valde inequilaterali, transversâ, compressâ; valvulis tenuibus; natibus prominulis, rugis concentricis; dentibus cardinalibus in valvulâ utrâque obliquis duplicibusque, lateralibus subrectis; margaritâ purpureâ.

Shell trapezoidal, very inequilateral, transverse, compressed; valves thin; beaks slightly prominent and concentrically wrinkled; cardinal teeth oblique and double in both valves; lateral teeth nearly straight; nacre purple.

Hab. Bayou Teche, Louisiana. W. M. Stewart.

My Cabinet.
Cabinet of the Academy of Natural Sciences of Philadelphia.
Cabinet of Mr Stewart.
Cabinet of Mr Hyde.

Diam. ·9, Length 1·4, Breadth 2·7 inches.

Shell trapezoidal, very inequilateral, transverse, compressed, angular behind; substance of the shell rather thin; umbonial slope subcarinate; beaks slightly prominent, placed near the anterior margin and concentrically wrinkled; carina much elevated; ligament long, narrow and nearly straight; epidermis dark brown, wrinkled and sometimes obscurely rayed; cardinal teeth oblique and double in both valves; lateral teeth nearly straight and lamelliform; anterior cicatrices distinct, posterior cicatrices confluent; dorsal cicatrices situated in the centre of the cavity of the beaks; cavity of the beaks shallow: nacre purple and iridescent.

Remarks.—This interesting species is one of the collection made by Mr Stewart in the Bayou Teche. It is a very distinct and beautiful species. Its form is more like a trapezium than that of any other species with which I am acquainted. It resembles most the *U. complanatus* (Soland.). It differs from it, however, in its remarkable outline, in its teeth, in the concentric wrinkles of the beaks, and in the beaks being placed nearer to the anterior margin. The angle of the posterior margin is also more acute. In the deep brown colour of the epidermis and in outline of the margin it approaches the *U. obesus* (nobis). It is, however, much less inflated.

Unio Taitianus. Plate IV. fig. 11.

Testa subtriangulari, obliquâ crassâque; valvulis antice crassioribus; dentibus cardinalibus grandibus et elevatis, lateralibus crassis et subcurvis; margaritâ albâ.

Shell subtriangular, thick and oblique; valves thicker anteriorly; cardinal teeth large and elevated; lateral teeth thick and slightly curved; nacre pearly white.

Hab. Alabama River. Judge Tait.

My Cabinet.

Diam. 1·1, Length 1·5, Breadth 1·5 inches.

Shell subtriangular, thick, oblique, depressed anterior to umbonial slope; substance of the shell very thick anteriorly and thin posteriorly; beaks very thick and much elevated; epidermis dark brown and wrinkled; cardinal teeth large, crenate and deeply cleft in the left valve, and emerging from a pit in the right; lateral teeth thick, slightly curved and nearly parallel with the line of the cardinal teeth; anterior cicatrices distinct, the great one forming a deep pit; posterior cicatrices distinct, the smaller one being placed at the end of the lateral tooth; dorsal cicatrices situated on the plate between the cardinal and lateral teeth; cavity of the beaks shallow; nacre pearly white.

Remarks.—There is no species which this so closely resembles as the *scalenius* (Rafin.). It is, however, less oblique and more expanded along the posterior basal margin, and the posterior margin forms a more obtuse angle. It is with great pleasure I name it after my friend, Judge Tait of Claiborne, Alabama, to whom science is greatly indebted for his exertions in making known the natural history of his vicinity.

Unio lacteolus. Plate VIII. fig. 19.

Testâ ellipticâ, transversâ, inæquilaterali, subinflatâ; valvulis subcrassis; natibus radiatis, plicis brevibus; dentibus cardinalibus in valvulâ utrâque duplicibus longisque; lateralibus longis, a cardinalibus separatis; margaritâ lacteolâ.

Shell elliptical, transverse, inequilateral, somewhat inflated; valves not thick; beaks having short radiating folds; cardinal teeth long and double in both valves; lateral teeth long and separate from the cardinal teeth; nacre pearly and milk white.

Hab. Rio de la Plata.

My Cabinet.

Cabinet of the Academy of Natural Sciences of Philadelphia.

Cabinet of W. Hyde.

Unio delodonta? Lam.

Diam. 1·2, Length 2, Breadth 3·2 inches.

Shell elliptical, transverse, inequilateral, somewhat inflated; substance of the shell not thick; beaks rounded, having short radiating folds; ligament rather short; epidermis dark brown and wrinkled; cardinal teeth long, oblique, nearly parallel with the margin and double in both valves; lateral teeth long, slightly curved and separated from the cardinal teeth by the absence of a plate; anterior and posterior cicatrices both confluent; dorsal cicatrices situated across the cavity of the beaks; cavity of the beaks rounded and not deep; nacre very pearly, milk white, iridescent behind.

Remarks.—I am indebted to the kindness of Dr Ward of Salem, for a perfect specimen of this species. In outline it approaches the *U. marginalis* (Lam.), but is less transverse. In the characters of its teeth it closely resembles that species. It differs from it in being more inflated, more wrinkled and in having a thicker nacre. In the possession of radiated folds on the beaks it differs altogether.

On the base of the cardinal tooth, near to the great cicatrix, there is a small deeply impressed cicatrix, resembling in its characters that of the *Hyria avicularis* (Lam.), mentioned at page 67, Vol. IV.

The specimen here figured belongs to the fine cabinet of Mr Hyde.

Symphynota globosa. Plate IV. fig. 12.

Testâ valde globosâ, inæquilaterali, pellucidâ; valvulis tenuiculis, natibus rotundissimis, incurvis; epidermide luteâ, lævissimâ; dentibus cardinalibus laminatis, lateralibus elevatis et laminatis; margaritâ albâ et iridescente.

Shell very globose, inequilateral, translucent; valves rather thin; beaks very round, incurved; epidermis very smooth and pale yellow; cardinal teeth lamellar; lateral teeth elevated and lamellar; nacre pearly white and iridescent.

Hab. River Ohio, 150 miles below Louisville. Col. Long.
My Cabinet.
Cabinet of the Academy of Natural Sciences of Philadelphia.
Cabinet of Peale's Museum.

Diam 2·4, Length 2·5, Breadth 3·5 inches.

Shell very globose, inequilateral, translucent, very smooth and bright; connate before and behind the beaks; substance of the shell rather thin; beaks very round, incurved; epidermis very smooth, and pale yellow or straw colour; umbones very round; cardinal teeth very lamellar, elevated, double in the right valve, and very crenate and single in the left; the line of the lateral and cardinal teeth form two curves; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices situated in the cavity of the beaks on the under side of the cardinal teeth; palleal cicatrix deeply impressed; cavity of the beaks very round and very deep; nacre thicker near the margin, beautifully pearly white and iridescent.

Remarks.—We owe to Col. Long and Mr T. Peale the knowledge of this singular and distinct species. Without a tubercle and almost rayless, for those on the posterior slope are obsolete, it is among the most beautiful and interesting species known. The Academy is in possession of four fine specimens, making a complete suite of different ages. Three of them are perfect enough to display the character of this genus, *Symphynota*, notwithstanding their great globosity. It is more capacious than any of the *Naïades* I have seen, and the light yellow or straw coloured epidermis is very peculiar—in form it most resembles, perhaps, the *Unio occidens* (nobis), but it has no rays. In the younger individuals there is a transverse rib-like appearance which I have noticed in no other species of the family.

Symphynota Woodiana. Plate V. fig. 13.

Testâ subpentagonâ, postice angulatâ, super umbones turgidâ, inæquilaterali, transversâ; valvulis tenuibus; epidermide tenebroso-fuscâ et obscuro-radiatâ; natibus undulatis; margaritâ albâ et iridescente.

Shell subpentagonal, angular behind, turgid over the umbones, inequilateral, transverse; valves thin; epidermis dark brown and obscurely rayed; beaks undulated; nacre pearly white and iridescent.

Hab. China. W. W. Wood.

My Cabinet.

Cabinet of the Academy of Natural Sciences of Philadelphia.

Diam. 1·5, Length 2·2, Breadth 3·5 inches.

Shell subpentagonal, angular behind, transverse, inequilateral, irregularly swollen over the umbones, slightly compressed somewhat before and below the umbones, posterior slope carinate; substance of the shell thin; epidermis wrinkled, dark brown with obsolete rays; ligament long and somewhat thick; beaks slightly inflated and undulated; cicatrices scarcely perceptible posteriorly, more deeply impressed anteriorly; cavity of the beaks shallow; cavity of the disk impressed immediately under the umbo; nacre pearly white and iridescent.

Remarks.—This species was first, I believe, brought to this city from Canton by Mr Wood* about five years since. To him I owe the first specimen I have seen. A younger and fine specimen I owe to the kindness of an estimable friend and accomplished conchologist, Mrs Corrie, who sent it to me from England about two years since, with a label "From China." It closely resembles the preceding species in many characters. All the specimens, however, which I have seen, perhaps half a dozen, retain the distinctive characteristics—the greater transverseness—the subpentagonal form—the slight compression anterior to the umbones—the dark epidermis—the absence almost entirely of rays and its want of a rich nacre—in all these it differs from the *magnifica* herein described. It is usually larger than the specimen figured.

Symphynota magnifica. Plate V. fig. 14.

Testâ subrotundâ, prope nates valde inflatâ, inæquilaterali, postice obtuso-angulatâ; valvulis tenuibus; epidermide luteâ, multis radiis viridibus; natibus

* On my return from Europe I found a box of shells sent to me by Mr Wood from Canton, in which were several specimens of a tuberculated *Unio*, which, on examination, I perceived immediately to be a new species, which the distinguished naturalist, John Edward Gray, Esq., of London, did me the honour, while in that city last June, to name *Leanus*.

inflatis, prope apices undulatis; cicatricibus vix cernendis; margaritâ pulchrâ et iridescente.

Shell subrotund, much inflated near the beaks, inequilateral, obtusely angular behind; valves thin; epidermis yellow, with numerous green rays; beaks inflated, near the tip undulated; cicatrices scarcely perceptible; nacre beautifully pearly and iridescent.

Hab. China. W. W. Wood.

My Cabinet.

Cabinet of the Academy of Natural Sciences of Philadelphia.

Cabinet of Mr Hyde.

Diam. 1·6, Length 2·3, Breadth 3·4 inches.

Shell subrotund, much inflated in the region of the beaks, inequilateral, connate before and behind the beaks, obtusely angular behind, rounded before, posterior slope carinate; substance of the shell thin; epidermis smooth, yellow with numerous beautiful green rays over the whole disk, which are darker on the posterior part and obsolete on the umbones; ligament long and thin; beaks inflated and terminated with about six nearly parallel undulations; teeth, none; cicatrices scarcely perceptible; cavity of the beaks shallow and rounded; nacre beautifully pearly and highly iridescent, sometimes tinged with salmon and pink.

Remarks.—Several specimens of this species have been within a few years received from Canton, and Mr Wood, to whom I owe one of mine, informed me that he believes it to be a native of that country, and most probably dwelling in the waters of the neighbourhood of Canton. It is certainly among the most beautiful of the genus which has come under my notice, and is remarkable for its great area, its inflation of the region of the beaks, its smooth epidermis, its splendid rays and exquisitely beautiful nacre, which no pencil can imitate. I have it of several different ages—when very young it is less rotund, being somewhat trapezoidal, the dorsal margin nearly straight and the rays obsolete. The specimen figured is not half the size of the largest specimen in my cabinet, but I have chosen it for its great perfection in having the valves completely connate before and behind the beaks.

ANODONTA FERUSSACIANA. Plate VI. fig. 15.

Testâ subcylindraceâ, inæquilaterali, inflatâ; margine dorsali sub natium apices curvâ; valvulis tenuibus; epidermide fulgidâ, obsolete radiatâ, olivæ colorem tenebrosum habente; natibus prominulis, binis ternisve undulis exiguis ad apices; cicatricibus conspicuis; margaritâ cœruleo-albâ et iridescente.

Shell subcylindrical, inequilateral, inflated; dorsal margin curved immediately under the point of the beak; valves thin; epidermis dark olive, shining, with obsolete rays; beaks somewhat prominent with two or three small undulations at tip; cicatrices perceptible; nacre bluish white and iridescent.

Hab. Ohio River, near Cincinnati. T. G. Lea.
My Cabinet.
Cabinet of the Academy of Natural Sciences of Philadelphia.
Cabinet of Mr Nicklin.
Cabinet of Professor Vanuxem.
Cabinet of the American Philosophical Society of Philadelphia.

Diam. 1·4, Length 1·8, Breadth 3·5 inches.

Shell subcylindrical, inequilateral, much inflated, more angular behind than before; dorsal margin curved immediately under the point of the beak; basal margin disposed to be emarginate; substance of the shell thin; epidermis dark olive, shining, with numerous obsolete rays, near the beaks lighter and destitute of rays; ligament rather short and thin; beaks somewhat prominent with two or three small undulations at tip; cicatrices perceptible; cavity of the beaks shallow; cavity of the disk deep and rounded; nacre bluish white and iridescent.

Remarks.—This species was received with the *A. incerta*, herein described, from the Ohio river. It differs from that species in having prominent beaks, in being more cylindrical, in its dark colour, and in the curve which exists immediately under the beaks, in which it resembles the *A. areolus* (Swainson). In the latter this curve is so strong and thick as to resemble an incipient tooth. In young specimens the epidermis is more on the yellow, and the rays greenish and bright.*

* Since the above description was made and the figure printed, I am in possession of several specimens from Illinois, beautifully and very distinctly rayed.

ANODONTA INCERTA. Plate VI. fig. 16.

Testâ lato-ellipticâ, postice subangulatâ, inflatâ, margine dorsali subrectâ ; valvulis tenuissimis ; epidermide subviride, obsolete radiatâ ; natibus complanatis et minute undulatis ; cicatricibus vix cernendis ; margaritâ cæruleo-albâ et iridescente.

Shell wide-elliptical, subangular behind, inflated, nearly straight on the dorsal margin ; valves very thin ; epidermis greenish with obsolete rays, beaks flattened and minutely undulated ; cicatrices scarcely perceptible ; nacre bluish white and iridescent.

Hab. Ohio River near Cincinnati. T. G. Lea.
My Cabinet.
Cabinet of the Academy of Natural Sciences of Philadelphia.
Cabinet of Professor Vanuxem.
Cabinet of P. H. Nicklin.

Diam. 1·2, Length 1·5, Breadth 3·2 inches.

Shell wide-elliptical, subangular behind, inequilateral, inflated, dorsal margin nearly straight, rounded before; substance of the shell very thin; epidermis very smooth, green and olive green with obsolete rays, three being more distinct on the posterior part of each valve; ligament long and thin; beaks flattened, minutely undulated near the tip which terminates with a minute point from which an indistinct line runs towards the posterior margin; cicatrices scarcely perceptible; cavity of the beaks scarcely perceptible; cavity of the disk deep and rounded; nacre bluish white and iridescent.

Remarks.—Among the earliest shells I procured from the Ohio, many years since, were several specimens of this fragile *Anodonta.* The difficulty of separating the species of a genus with so few tangible characters induced me to lay this aside with some other species until more leisure would permit a thorough examination. It perhaps most closely resembles the *A. cataracta* of Say, but differs from it peculiarly in the flatness of the beaks. It is generally more inflated, particularly near the umbonial slope. It resembles the *A. Ferussaciana* (nobis), the description of which see. The young differ from the old in being much compressed and in having rays only on the posterior part of the shell, where the three on each valve are distinctly visible—they are also more straight on the dorsal margin. The smoothness and polish, as well as the brightness of the green of some of the specimens are very remarkable.

ANODONTA STEWARTIANA. Plate VI. fig. 17.

Testâ rotundato-ovatâ, valde inflatâ; valvulis pertenuibus; epidermide subasperâ, tenebroso-viridi, natibus prominentibus, apicibus granulatis; cicatricibus subobsoletis aut vix perspicuis; margarita cœruleo-albâ.

Shell rotundo-ovate, much inflated; valves very thin; epidermis roughish, olive green; beaks prominent and granulate at tip; cicatrices scarcely perceptible; nacre bluish white.

Hab. River Teche, Louisiana. W. M. Stewart.
My Cabinet.
Cabinet of the Academy of Natural Sciences of Philadelphia.
Cabinet of Mr Stewart.

Diam. 1·8, Length 2, Breadth 3·1 inches.

Shell rotundo-ovate, much inflated, subangular behind; dorsal line slightly curved; substance of the shell thin; epidermis somewhat rough, olive green and obsoletely rayed; beaks prominent, granulate at tip in a short double series; cicatrices scarcely perceptible; cavity of the beaks deep and incurved; cavity of the disk deep and rounded; nacre bluish white and iridescent, sometimes tinged with salmon colour about the region of the beaks.

Remarks.—I owe this species with numerous others to my friend Mr Stewart who procured and gave it to me more than two years since. I did not then describe it, although I believed it to be new, intending it to accompany some others which are now embodied in this memoir. It is an interesting species, being much inflated—the young specimens approached the globose form. It is most similar in form to the *gibbosa* (Say), but is perhaps less inflated, does not possess a polished epidermis, and has granulations at the termination of the beaks, while the *gibbosa* has undulations. The inflation of the *Stewartiana* is more spherical, the other is gibbous. The posterior slope of the young specimen is decorated with six distinct green rays, there being three on each valve.

Anodonta palna. Plate VII. fig. 18.

Testâ subovatâ, inæquilaterali, subcompressa; valvulis subcrassis; epidermide olivaceâ et obsolete radiatâ; natibus prominentibus; apicibus granulatis; cicatricibus perspicuis; margaritâ albâ; sed in natium cavo interdum colore salmonis tinctâ.

Shell subovate, inequilateral, rather compressed; valves somewhat thick; epidermis olive with obsolete rays; beaks prominent and granulate at tip; cicatrices perceptible; nacre white, sometimes salmon in the cavity of the beaks.

Hab. Bear Grass Creek, near Louisville. Mr T. H. Taylor.
My Cabinet.
Cabinet of the Academy of Natural Sciences of Philadelphia.
Cabinet of Mr Ronaldson.

Diam. 2·3, Length 3·1, Breadth 5·6 inches.

Shell subovate, inequilateral, rather compressed, subangular behind; dorsal line slightly curved; substance of the shell thick; epidermis smooth, olive to dark green, brighter on the beaks; rays obsolete; ligament long and thick; beaks elevated, granulate at tip; cicatrices perceptible; cavity of the beaks rather deep and rounded; cavity of the disk somewhat flattened; nacre white, sometimes salmon coloured in and about the cavity of the beaks.

Remarks.—This species of Anodonta offers quite a large area in the circumference of the disk. Some specimens are, however, more transverse than the one here described. It has a predisposition to salmon colour in the region of the cavity of the beaks, and this is sometimes of a very deep tint. The colour is irregularly distributed, sometimes quite in spots, and a roughness, apparently a disease, often accompanies it and produces a carious state of the nacre. It perhaps most closely resembles the *A. cataracta* (Say); but is usually less inflated, is thicker in the substance of the shell, and less transverse.

Helicina lens. Plate XIX. fig. 56.

Testâ parvâ, lenticulari, supra luteâ, subtus rufâ; anfractibus tribus, quorum inferiori carinato; spirâ plano-convexâ; aperturâ dilatatâ; labro crasso; columellâ subcallosâ et luteolâ.

Shell small, lenticular, yellow above and red below; whorls three, inferior one carinate; spire plano-convex; aperture dilated; outer lip thick; columella thinly coated and yellowish.

Hab. Feejee Islands. W. W. Wood.

My Cabinet.

Diam. 5-20ths, Length 4-20ths of an inch.

The smaller figure is of the size of nature.

Remarks.—The lenticular form and sharp carina of the body whorl distinguish this species. Within it is orange, and about the base of the shell there is a disposition to yellow.

Helicina pulcherrima. Plate XIX. fig. 57.

Testâ subviridi, subglobosâ, crassâ, minute striatâ; anfractibus quaternis, quorum infimo fasciâ albo-fuscâ induto; spira obtusâ; aperturâ dilatatâ; labro albo et reflexo; columellâ callosâ, albâ, fulgenti, tuberculo parvo ad basim.

Shell subglobose, greenish, thick, finely striate; whorls four, the body whorl having an indistinct white and brown band; spire obtuse; aperture dilated; outer lip white and reflected; columella white, thickly coated and shining, with a small tubercle at the bottom.

Hab. Java?

My Cabinet.

Diam. ·8, Length ·7 of an inch.

Remarks.—This is perhaps the finest species yet known of the genus. It is remarkable for its size and weight, and the strong and wide callus on the columella. Under the epidermis it varies from a dark orange to lemon yellow. A depauperated specimen in my possession would scarcely be recognized as the same species, owing to the density of the orange colour. The apex of the perfect shell, having but a thin epidermis, presents an orange appearance,—this colour may also be observed on the inside of the shell. At the base of the columella there is an obsolete tubercle. The band sometimes consists of a single white line only. It is believed these specimens formed part of the collection brought from Java by Mr Shillaber.

Helicina virginea. Plate XIX. fig. 58.

Testâ subconicâ, apice acutâ, subtus inflatâ, crassâ, transversim multisulcatâ; anfractibus senis; spira elevatâ; aperturâ valde dilatatâ; labro effuso; columellâ subcallosâ.

Shell subconical, acutely pointed, inflated below, thick, with many transverse furrows; whorls six; spire elevated; aperture much dilated; outer lip effuse; columella thinly coated.

Hab. Java?

Helicina striata? Lam.

My Cabinet.

Diam. ·8, Length ·8 of an inch.

Remarks.—This species came in the same collection as that described last. It is nearly of the same diameter. It differs from it altogether in form and colour. It is remarkable for its acutely pointed apex, its milk-white appearance, and its numerous furrows. The outer lip may, with propriety, be said to be effuse rather than reflected.

Helix muscarum. Plate XIX. fig. 59.

Testâ globosâ, crassâ, politâ, longitudinaliter nitide striatâ, subfuscâ; maculis numerosis irregularibus minutis, et fasciis albis subnigris et fuscis indutâ; anfractibus ternis; spirâ rotundatâ; apice albâ; aperturâ subrotundâ; labro acuto, intus crassescenti; labio subrufo; columellâ lævi albâque.

Shell globose, thick, polished, longitudinally and finely striated, light brown, furnished with numerous irregular minute spots, and blackish brown and white bands; whorls three; spire rounded; apex white; aperture nearly round; right lip sharp, growing thicker within; left lip light red; columella smooth and white.

Hab. Society Islands, Pacific Ocean. Lieutenant Dornin.
My Cabinet.

Diam. ·8, Length ·7 of an inch.

Remarks.—This curiously and elegantly painted shell I owe to Lieutenant Dornin, who, when on board the sloop of war Vincennes on her voyage round the world, very kindly collected for me many rare and fine specimens. It is eminently distinguished by its compound band, its globosity, and its innumerable minute spots. The columella is somewhat thickened by a dark pink deposit.

Helix purpuragula. Plate XIX. fig. 60.

Testâ obtuso-conicâ, crassâ, inferne planulatâ, politâ, longitudinaliter minute striatâ, superne luteâ et fusco-virgatâ, inferne luteâ, in medium anfractum obscuro-fasciatâ, subsuturam maculatâ, imperforatâ; anfractibus quinis; spirâ obtuso-conicâ; aperturâ ovatâ, intus purpureâ; labro reflexo, prope basim majori; columellâ lævi, ad basim subconcavâ.

Shell obtusely conical, thick, flattened below, polished, minutely and longitudinally striate, above yellow and striped with brown, below yellow, obscurely banded on the middle of the whorl, irregularly spotted on the inferior part of the suture, imperforate; whorls five; spire obtusely conical; aperture oval, purple inside; outer lip subreflected, enlarged towards the base; columella smooth and impressed at base.

Hab. Java?

My Cabinet.

Diam. ·9, Length ·6 of an inch.

Remarks.—The solidity, smoothness and purple colour of this species, which is supposed to have been of Mr Shillaber's collection, will serve to distinguish it. Like the *mamilla*, herein described, it has a thick lip and is impressed at the base of the columella. The two specimens which I have differ much in the arrangement of colour. In one the inferior portion is almost white, and a dark interrupted band encircles the middle of the whorl.

Helix ovum reguli. Plate XIX. fig. 61.

Testâ super et subtus planulatâ, colore columbino tinctâ, minutis irregularibus maculis numerosis, imperforatâ; anfractibus quaternis; spirâ valde depressâ; aperturâ subovatâ, intus purpurascenti; labro acuto, subreflexo; columellâ lævi, ad basin subconcavâ.

Shell flattened above and below, dove coloured, with numerous irregular minute dots, imperforate; whorls four; spire much flattened; aperture suboval, purplish inside: outer lip somewhat reflected but sharp; columella smooth, at base impressed.

Hab. Java?

My Cabinet.

Diam. ·8, Length ·4 of an inch.

Remarks.—The very peculiar colour and the minute dots of this beautiful and interesting species eminently distinguish it from all other species which have come under my notice. The line of the superior part of the lip is almost parallel with the corresponding inferior part, and the outer posterior is consequently more round. In my specimens there are two very indistinct bands, rather lighter than the ground. In colour it greatly resembles a spotted small egg of a bird. It is supposed to have come from Mr Shillaber's collection.

Helix monodonta. Plate XIX. fig. 62.

Testâ superne subconicâ, inferne inflatâ, lævi, albâ, fasciis duabus fuscis, imperforatâ; anfractibus ternis; spirâ obtusâ; aperturâ subrotundâ; labro acuto, subreflexo, subtus unico dente induto; columellâ lævi.

Shell subconical above, inflated below, smooth, white, with two brown bands, imperforate; whorls three; spire obtuse; aperture nearly round; outer lip somewhat reflected but sharp, having a single tooth on the lower limb; columella smooth.

Hab. Java?

My Cabinet.

Diam. 9-20ths, Length 7-20ths of an inch.

Remarks.—The two brown bands and single tooth of this species, together with the absence of an umbilicus, may serve to distinguish it. The superior termination of the lip is bent down towards the base of the columella. It is supposed to be from the collection of Mr Shillaber.

Helix cyclostomopsis. Plate XIX. fig. 63.

Testâ subglobosâ, superne depressâ, inferne inflatâ, longitudinaliter et minute striatâ, pellucidâ, corneâ, late umbilicatâ; anfractibus quaternis; spirâ depressâ; aperturâ subcirculari; labro crasso et reflexo; columellâ lævi, ad basin crassescenti.

Shell subglobose, depressed above, inflated below, longitudinally and minutely striate, translucent, horn coloured, widely umbilicate; whorls four; spire depressed; aperture nearly a circle; outer lip thick and reflected; columella smooth, at the base thickened.

Hab. . . . .

My Cabinet.

Diam ·9, Length ·6 of an inch.

Remarks.—In its aperture this species has a strong resemblance to a *Cyclostoma.* The superior and inferior portions of the lip do not, however, join by one-fifth of a circle—the resemblance is strong in the thickness and reflection of the lip. The last whorl is very round—the umbilicus large and partly covered.

Helix mamilla. Plate XIX. fig. 64.

Testâ solidâ, elevatâ, obtuso-conicâ, inferne rotundatâ, imperforatâ, colore columbino tinctâ, longitudinaliter nitide striatâ, fasciis duabus obsoletis indutâ, apice subrufo; anfractibus quinis, rotundatis; spirâ exsertâ; aperturâ subrufâ, ovatâ; labro subreflexo, crasso, prope basin majori; columellâ lævi, ad basin subconcavâ.

Shell solid, elevated, obtusely conical, rounded below, imperforate, dove coloured, transversely and finely striate, with two obsolete bands, pink at the apex; whorls five and rounded; spire elevated; aperture pink, oval; outer lip somewhat reflected, thick, enlarged towards the base; columella smooth, at the base impressed.

Hab. . . . .

My Cabinet.

Diam. ·8, Length ·7 of an inch.

Remarks.—I have rarely met with a more beautiful and interesting species of the genus than the above. It is eminently distinguished by its solidity, its thick, smooth and beautifully coloured lip, its fine delicate colour, and its elevated and red tipped spire. The columella is somewhat thickened and deeply impressed at the base.

It is to be regretted that the habitat of this species is not known. It was met with accidentally at a dealer's.

Helix diaphana. Plate XIX. fig. 65.

Testâ latâ, superne depressâ, inferne inflatâ, longitudinaliter et nitide striatâ; subluteâ, obscure bifasciatâ super medium anfractum, umbilicatâ; anfractibus quaternis; spirâ planulatâ; aperturâ magnâ et subrotundâ; labro simplici; columellâ brevissimâ lævique.

Shell wide, depressed above, inflated below, longitudinally and finely striate, pale yellow, obscurely banded above the centre of the whorl, umbilicated; whorls four;

spire flattened; aperture large and nearly round; outer lip simple; columella very short and smooth.

Hab. . . . .

My Cabinet.

Diam. 1·4, Length ·7 of an inch.

Remarks.—This species has a strong resemblance to *H. citrina.* It may be distinguished from that species by its colour, which is more pale, being almost a light horn colour; by its being more flattened, and by its band, which is white bordered on each side by a delicate brown line. The umbilicus is small.

HELIX HIMALANA. Plate XIX. fig. 66.

Testâ sinistrosâ, subcarinatâ, tenui, subdiaphanâ, umbilicatâ, superne subconvexâ, inferne inflatâ, longitudinaliter et transversim minute striatâ, superne fusco-luteâ, inferne fuscâ, prope carinam tenebrosiori; anfractibus quaternis; spirâ obtusâ; aperturâ late rotundatâ; labro simplici et acuto; columellâ brevi.

Shell sinistral, subcarinate, thin, translucent, umbilicated, obtusely convex above, inflated below, longitudinally, transversely and minutely striate, superior part brownish yellow, inferior part brown, being more intense near the carina; whorls four; spire obtuse; aperture widely rounded; outer lip simple and sharp; columella short.

Hab. Himalaya Mountains. Dr Burrough.

My Cabinet.

Cabinet of Dr Burrough.

Cabinet of the Academy of Natural Sciences of Philadelphia.

Cabinet of Mr Hyde.

Diam. 1·1, Length ·7 of an inch.

Remarks.—In the splendid collection of objects of natural history brought from India and other countries by Dr Burrough was this species, which Dr B. procured himself among the Himalaya mountains. It is easily distinguished from any species I am acquainted with, and approaches most closely to the *H. lævipes* (Fer.). Its sinistral opening, its translucency, and its colours are very characteristic. On the inferior part of the carina, which is obtuse, the brown colour is more intense—on the superior part the yellow is brightest.

HELIX VESICA. Plate XIX. fig. 67.

Testâ tenui, pellucidâ, superne elevatâ et fusco-luteâ, inferne inflatâ albâque, transversim minute striatâ, umbilicatâ, anfractibus quinis; spirâ obtuso-conicâ; aperturâ subrotundâ; labro tenui et reflexo, inferne crassescenti; columellâ lævi.

Shell thin, transparent, elevated and brownish yellow above, inflated and white below, longitudinally and minutely striate, umbilicated; whorls five; spire obtusely conical; aperture nearly round; outer lip thin and reflected, on the lower part slightly thickened; columella smooth.

Hab. . . . .

My Cabinet.

Diam. ·7, Length ·5 of an inch.

Remarks.—This species is peculiarly transparent, and very strongly resembles the cuticle of a blister or the bladder of a fish. This character, and its pale brownish-yellow superior portion, and white inferior portion, together with its longitudinal striæ, eminently distinguish it. The lower part of the reflected lip is so much thickened as almost to form a tooth.

HELIX CINCTA. Plate XIX. fig. 68.

Testâ superne depressâ, inferne inflatâ, longitudinaliter striatâ, umbilicatâ, rufo-fuscâ, fasciam fuscam aut nigram super medios anfractus habente; anfractibus quaternis; spirâ planulatâ, aperturâ subrotundatâ; labro simplici; columellâ lævi.

Shell depressed above, inflated below, longitudinally striate, umbilicated, reddish brown, with a dark brown or black band above the middle of the whorls; whorls four; spire flattened; aperture nearly round; outer lip simple; columella smooth.

Hab. Java?

My Cabinet.

Diam. ·9, Length ·6 of an inch.

Remarks.—The fine reddish-brown ground and intensely dark band distinguish this fine *Helix*. In my specimen, which is the only one I have seen, the inferior margin of the band has, adjoining it, an obscure band, of a tint somewhat lighter than the ground. It should be observed, that when other specimens may be examined, the bands may not prove so regular as in the present specimen. Around the umbilicus the colour is more pale.

HELIX WOODIANA. Plate XIX. fig. 69.

Testâ supra obtuso-conicâ, inferne inflatâ, longitudinaliter et nitide striatâ, albidâ, pellucidâ, fasciâ unicâ in medium anfractum, late umbilicatâ; anfractibus quaternis; spira obtusâ, aperturâ rotundatâ latâque; labro reflexo; columellâ lævi.

Shell obtusely conical above, inflated below, longitudinally and finely striate, pale and translucent, with a single band on the centre of the whorl, widely umbilicate; whorls four; spire obtuse; aperture wide and round; outer lip reflected; columella smooth.

Hab. China near Canton. W. W. Wood.
My Cabinet.
Cabinet of Mr Hyde.
Cabinet of P. H. Nicklin.

Diam. ·6, Length ·4 of an inch.

Remarks.—Among a number of fine shells taken by Mr Wood, who devoted himself much to natural history during some years' residence in China, was this species and the *globula* herein described, both from the neighbourhood of Canton. It may be distinguished by its brown band, its round aperture and enlarged umbilicus.

Helix globula. Plate XIX. fig. 70.

Testâ globosâ, tenebroso-corneâ, pellucidâ, umbilicatâ, longitudinaliter striatâ; anfractibus quinis; spirâ obtuso-elevatâ; aperturâ latâ et subrotundâ; labro simplici; columellâ lævi.

Shell globose, dark horn colour, translucent, umbilicated, longitudinally striate; whorls five; spire obtusely elevated; aperture wide and round; outer lip simple; columella smooth.

Hab. China, near Canton. W. W. Wood.
My Cabinet.
Cabinet of Mr Hyde.

Diam. ·6, Length ·5 of an inch.

Remarks.—I owe to the kindness of Mr Wood the specimen which is here figured. It is remarkable for its globular form and its dark horn-coloured epidermis. It has somewhat the aspect of a *Paludina.*

Paludina bi-monilifera. Plate XIX. fig. 71.

Testâ abbreviato-turritâ, tenebroso-corneâ, apice obtusâ; anfractibus seriebus duabus nodulorum circumdatis; nodulis seriei inferioris anfractuum superiorum suturâ celatis; nodulis seriei superioris majoribus, et super omnes anfractus conspicuis; suturis profundis et irregularibus; labro sub-biangulato; basi subangulatâ.

Shell obtusely turrited, dark horn colour; apex obtuse; whorls furnished with two rows of nodules; the nodules of the lower row of the upper whorls hidden by the suture, those of the upper row larger, and visible on all the whorls; sutures deep and irregular; outer lip sub-biangular; base subangular.

Hab. Alabama River. Judge Tait.
My Cabinet.
Cabinet of Professor Vanuxem.
Cabinet of the American Philosophical Society.
Cabinet of the Academy of Natural Sciences of Philadelphia.

Cabinet of P. H. Nicklin.
Cabinet of Baron Ferussac.

Diam. 1·1, Length 1·8 inches.

Remarks.—This superb *Paludina*, which far surpasses in point of beauty any of our species yet known, I owe to the kindness of Judge Tait. Its beautiful double tuberculated cincture at once distinguishes it from all described species. Some specimens are furnished with dark purple bands which beautifully decorate the interior of the shell, and give a dark rich green colour to its fine epidermis. In the others these are wanting, and the epidermis then has a clear and more yellow appearance. The sutures being formed immediately over the lower row of tubercles, they cause its line to be very irregular; and this row itself is hidden on the upper whorls.

SUPPLEMENT.

Read before the American Philosophical Society, March 15th, 1833.

SINCE I had the pleasure to present to this Society, nearly a year since, a Memoir on the *Naïades* and some other families, I have had it in my power to procure several interesting species, hitherto unnoticed by naturalists. In the large collection of rare shells which I procured in Europe while there last year, some of these were discovered; and most of them are, perhaps, the only specimens known, being now first described. The observations on, and corrections of, Lamarck's *Naïades*, it is hoped, will prove useful to the American conchologist.

Unio parallelopipedon. Plate VIII. fig. 20.

Testâ oblongâ, subcylindraceâ, transversâ, valde inæquilaterali, postice angulatâ, inflatâ, marginibus dorsi et baseos parallelis; valvulis subcrassis; natibus prominulis, retusis; epidermide fere nigrâ; dentibus cardinalibus obliquis, cristatis; lateralibus longis rectisque; margaritâ albâ et iridescente.

Shell oblong, subcylindrical, dorsal and basal margins parallel, transverse, very inequilateral, angular behind, inflated; valves rather thick; beaks somewhat elevated, retuse; epidermis almost black; cardinal teeth oblique, crested; lateral teeth long and straight; nacre pearly white and iridescent.

Hab. River Parana, Province of Corrientes.

My Cabinet.

Cabinet of Dr Burrough.

Cabinet of the Academy of Natural Sciences of Philadelphia.

Diam. ·9, Length 1·2, Breadth 2·7 inches.

Shell oblong, subcylindrical, dorsal and basal margins parallel, transverse, very inequilateral, flattish on the sides, angular behind, inflated; substance of the shell rather thick; beaks rather elevated and placed near the anterior margin; ligament long and thin; umbones flattened; umbonial slope carinate; posterior slope elevated into a carina; epidermis finely wrinkled and almost black; cardinal teeth oblique and crested, larger in the right valve; lateral teeth long and straight; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices placed in the centre of the cavity of the beaks; cavity of the beaks shallow; nacre pearly white and iridescent.

Remarks.—This species is from the Burrough collection, and is distinct from any I have seen. It resembles somewhat, in the outline of the margin, the *nasutus* of Say. The posterior slope does not, however, decline so much, the dorsal and basal margins being nearly parallel. In being subcylindrical it resembles the *cylindricus* of Say; it has not, however, either tubercles or arrow-headed markings. The very dark colour of its epidermis is peculiar.*

* Since the above description and the figure were made, I have seen a more perfect specimen in the possession of Dr Burrough, which has the beaks but little eroded. In

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UNIO COOPERIANUS. Plate VIII. fig. 21.

Testâ suborbiculatâ, nonnihil obliquâ, inequilaterâ, dimidio postico tuberculatâ; valvulis crassis; natibus prominentibus; dentibus cardinalibus subgrandibus; lateralibus subbrevibus, crassis rectisque; margaritâ albâ et carnis colore tinctâ.

Shell suborbicular, somewhat oblique, inequilateral, tuberculated on posterior half; valves thick; beaks elevated; cardinal teeth rather large; lateral teeth rather short, thick and straight; nacre flesh coloured and white.

Hab. River Ohio. T. G. Lea.
My Cabinet.
Cabinet of Mr Cooper.

Diam. 1·9, Length 2·8, Breadth 3·2 inches.

Shell suborbicular, somewhat oblique, inequilateral, irregularly tuberculated on the posterior half; substance of the shell thick; beaks thick and elevated; ligament rather short and thick; epidermis wrinkled, dark rusty brown; rays scarcely visible; cardinal tooth rather large and widely cleft in the left valve, single and emerging from a pit in the right valve; lateral teeth rather short, thick and straight; anterior and posterior cicatrices both distinct; dorsal cicatrices situated on the under part of the cardinal tooth; cavity of the beaks deep and angulated; nacre flesh coloured and white, the white usually forming a broad border between the palleal cicatrix and the margin.

Remarks.—This species very closely resembles, in most of its characters, both the *verrucosus* (Barnes) and *pustulosus* (nobis). It differs from the first in never being chocolate coloured. It is rarely, I believe, entirely white like the latter. The epidermis is dark, and when rays can be seen on it, they will be found to be pencilled, and not one broad

this I found a character not perceptible in the eroded one from which the description was made, the beaks being furnished with radiated folds nearly similar to those of the *lacteolus* and *Burroughianus* described herein. This character seems to prevail very much in the South American *Uniones*. Among the numerous species described from North America, none yet have been observed to possess this character.

interrupted one like the *pustulosus*. There is a great peculiarity in the flesh or pink colour of the nacre, which is disposed to be clouded, and to be of a stronger hue about the teeth, while the cavity of the beak is nearly white.

I dedicate this species to my friend, William Cooper, Esq., as a slight acknowledgement of the many favours received in the way of communications, and the loan of specimens.

UNIO EMARGINATUS. Plate IX. fig. 22.

Testâ sub-ellipticâ, ad basim emarginatâ et compressâ, transversissimâ, valde inæquilaterâ, postice sub-triangulatâ; valvulis subcrassis; natibus prominulis, apicibus undulatis; epidermide viridi-luteâ; dentibus cardinalibus parvis, obliquis, et in valvulâ utrâque duplicibus; lateralibus longis subcurvisque; margaritâ albâ et iridescente.

Shell sub-elliptical, emarginate and compressed at base, very transverse, very inequilateral, sub-biangular behind; valves somewhat thick; beaks rather elevated and undulated at tip; epidermis greenish yellow; cardinal teeth small, oblique and double in both valves; lateral teeth long and slightly curved; nacre pearly white and iridescent.

Hab. . . . .

My Cabinet.

Diam. 1, Length 1·3, Breadth 2·8 inches.

Shell subelliptical, emarginate and compressed at base, very transverse, very inequilateral, sub-biangular behind, elevated along the umbonial slope, flattened on the umbones; substance of the shell somewhat thick; beaks rather elevated, retuse and undulate at the tip; ligament long and thin; epidermis finely wrinkled, greenish yellow, along the posterior slope green; cardinal teeth small, oblique and double in both valves; lateral teeth long and slightly curved; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices situated on the under part of the cardinal tooth; cavity of the beaks subangular and wide; nacre pearly white and iridescent.

Remarks.—I procured two opposed valves of different individuals of this species, which nearly match, of Mr Stutchbury, a well known and extensive dealer in London. He could not give me the least idea of its native country. From its general appearance I should presume it to come from a southern latitude, perhaps from New Holland. It is rather peculiar in its outline, being more emarginate at base than any species with which I am acquainted. The emargination is not, however, so great as in the *Mya margaritifera* (Lin.), *Alasmodonta arcuata* (Barnes). It approaches most closely the *Unio subtentus* (Say), but differs from it in the total absence of folds or "ribs" on the posterior slope. In the two valves which I possess there appear to be no rays, unless the green of the posterior slope be denominated a single broad one. The emargination and compression of the base cause the posterior part of the cavity of the shell to be effuse.

Unio Conradicus. Plate IX. fig. 23.

Testâ ellipticâ, transversâ, inæquilaterâ, parte posteriori plicatâ; valvulis tenuibus; natibus ad apices nitide undulatis; dentibus cardinalibus parvis et erectis; lateralibus indistinctis; margaritâ antice albâ, postice iridescente et in cavo fusco purpureâ.

Shell elliptical, transverse, inequilateral, folded on the posterior parts; valves thin; beaks finely undulated at tip; cardinal teeth small and erect; lateral teeth not perfectly defined; nacre white anteriorly, iridescent posteriorly, and brownish purple in the cavity.

Hab. . . . . Professor Troost.

My Cabinet.

Cabinet of Professor Troost.

Diam ·6, Length ·8, Breadth 1·8 inches.

Shell elliptical, transverse, inequilateral, indistinctly folded on the posterior parts; substance of the shell thin behind, thicker before; beaks slightly elevated and finely undulated at tip; ligament rather long and thin; epidermis finely wrinkled, yellowish brown, with numerous indistinct greenish rays, which on the posterior part are disposed to be clouded; cardinal teeth small, erect, disposed to be lobed; lateral teeth long, slightly curved, not perfectly defined, having but a small cleft in the left valve; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices in the centre of the cavity of the beaks; cavity of the beaks shallow and tinged with brownish purple; nacre white anteriorly, thinner and very iridescent posteriorly.

Remarks.—I owe to the kindness of professor Troost this little species, and name it after an indefatigable naturalist, Mr T. A. Conrad. It belongs to that group which is distinguished by an immature hinge, and which I have noticed in my remarks on the *U. Hildrethius.* The *U. Conradius* certainly resembles that shell closely. It is, however, less cylindrical, and has the teeth more perfect. It also has rays and undulations which I have not observed on the other. In outline it more closely resembles the *U. iris* (nobis), but differs in the teeth and in the rays. Having but two specimens of this species to examine, some of the characters may be found to differ in other specimens. One of these is slightly emarginate at the basal margin.

Unio divaricatus. Plate IX. fig. 24.

Testâ ellipticâ, transversâ, subcompressâ, valde inæquilaterâ; valvulis tenuibus; natibus plicis pulchris divaricatis; dentibus cardinalibus parvis, compressis; lateralibus longis et subtenuibus; margaritâ albâ et iridescente.

Shell elliptical, transverse, rather compressed, very inequilateral; valves thin; beaks with beautiful divaricating folds; cardinal teeth small, compressed; lateral teeth long and rather thin; nacre white and iridescent.

Hab. Egypt. Duke de Rivoli.

My Cabinet.

Diam. ·5, Length ·9, Breadth 1·4 inches.

Shell elliptical, transverse, somewhat compressed, very inequilateral; substance of the shell thin; beaks covered with beautiful folds diverging from their apex; ligament rather short and slender; epidermis greenish, smooth; cardinal teeth small, compressed, double in the right valve, and single in the left; lateral teeth long, rather thin and nearly straight; anterior cicatrices slightly confluent; posterior cicatrices confluent; dorsal cicatrices situated in the centre of the cavity of the beaks; cavity of the beaks shallow and subangular; nacre white and iridescent.

Remarks.—This beautiful little species I procured from the cabinet of the Duke de Rivoli in Paris. It appears to me to be inedited, and may perhaps have been considered a transverse variety of the *corrugatus* (Lam.). It ought not to be confounded with that species, being much more transverse, and the folds of the beaks differing. Lamarck, in his description of the *corrugatus*, says, "rugis angulato-flexuosis." The folds of the *divaricatus* are well marked, without angles, and diverge from the point of the beaks.

UNIO CORRIANUS. Plate IX. fig. 25.

Testâ angusto-ellipticâ, transversissimâ, valde inæquilaterâ, postice subangulatâ; valvulis tenuissimis; natibus vix prominulis; dentibus cardinalibus tenuibus et laminatis; lateralibus longis, tenuibus, subrectisque; margaritâ albâ et iridescente.

Shell narrow-elliptical, very transverse, very inequilateral, subangular behind; valves very thin; beaks scarcely prominent; cardinal teeth thin and bladed; lateral teeth long, thin and nearly straight; nacre pearly white and iridescent.

Hab. India. Mrs Corrie.

My Cabinet.

Cabinet of the Academy of Natural Sciences of Philadelphia.

Diam. ·6, Length 1, Breadth 2·1 inches.

Shell narrow elliptical, very transverse, very inequilateral, subangular behind; dorsal line nearly straight; substance of the shell very thin; beaks very slightly elevated and minutely waved at the tip; ligament long and slender; epidermis smooth, dark brown; rays none; cardinal teeth thin, bladed, single in the *left* valve and double in the *right;* lateral teeth long, thin, bladed and nearly straight; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices situated nearly in the centre of the cavity of the beaks; cavity of the beaks exceedingly shallow; nacre pearly white and iridescent.

Remarks.—I am indebted to an amiable and intelligent friend, Mrs Corrie of Birmingham, England, for this new species, which comes from Calcutta; and to her I dedicate it, as a mark of sincere friendship. It closely resembles the *U. marginalis* of Lamarck, but differs from that species in being more transverse, in the beaks being more retuse, in the dorsal line being nearly straight, and in its not being possessed of a light border along the margin. The cardinal teeth are remarkably thin, and form nearly a line with the lateral teeth.

Unio Grayanus. Plate IX. fig. 26.

Testâ lanceolatâ, transversissimâ, antice rotundatâ et postice acutissime angulatâ, prope nates et partem posticam plicatâ; lateribus planulatis; clivo umboniali subcarinato; valvulis tenuibus; natibus prope marginem anticam locatis, depressis; epidermide luteolâ, obsolete radiatâ; dentibus cardinalibus in valvulâ utrâque duplicibus et erectis; lateralibus longissimis, tenuibus, sub-erectisque; margaritâ pulchrâ et iridescente.

Shell lanceolate, very transverse, rounded before and very acutely angular behind, plicate about the beaks and posterior part of the shell, flattened on the sides; umbonial slope ridged; valves thin; beaks depressed, placed near the anterior margin; epidermis yellowish with obsolete rays; cardinal teeth double in both valves and erect; lateral teeth very long, thin and nearly straight; nacre beautifully pearly and iridescent.

Hab. China.

My Cabinet.
Cabinet of Mr Hyde.
Cabinet of Mr Gray, London.

Diam. ·6, Length ·8, Breadth 3·3 inches.

Shell lanceolate, very transverse, very inequilateral, rounded before and very acutely angular behind, irregularly folded in the region of the beaks, several larger folds on the anterior slope, on the posterior portion the folds are parallel being nearly perpendicular to the basal margin, flattened on the sides; umbonial slope elevated into a ridge, green; substance of the shell thin; beaks depressed, placed very near to the anterior margin; ligament thin, not very long; epidermis finely wrinkled, yellowish with obsolete rays, disposed to be greenish on the posterior part; cardinal teeth double in both valves, compressed and erect; lateral teeth very long, thin and nearly straight; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices situated in the cavity of the beaks; cavity of the beaks very small; nacre beautifully pearly and iridescent.

Remarks.—This is perhaps the most extraordinary *Unio* that has yet fallen to the lot of a naturalist to describe. When we cast our eyes over all the species, and then rest them on this, we shall be ready to exclaim, that nothing hereafter belonging to this genus can astonish us. Its latitude is so great, that one at first sight can scarcely believe it to belong to the family *Naïades.* Its great transverseness causes the lateral teeth to be exceedingly long, and that character, together with the acutely angular posterior margin, gives the shell the form of a crane's beak. In outline it does not approach any species I know, and therefore there can be no comparison made. I procured it of a dealer in London, and dedicate it to my friend, John Edward Gray, Esq. of the British Museum, one of the most distinguished naturalists in Great Britain, and to whose great kindness and attention while in London I am much indebted. I know of no zoologist who has, in that country, pursued our favourite science with more ardour or more success, and it is only due to him, while it gives me great pleasure to render him this tribute of respect in placing his name to one of the most interesting species of the whole family.

Unio Burroughianus. Plate X. fig. 27.

Testâ subrotundâ, inæquilaterali, compressâ, postice subangulatâ; natibus oblique plicatis, prominulis; valvulis subcrassis; epidermide tenebroso-fuscâ; dentibus cardinalibus magnis, elevatis et laminatis, lateralibus subrectis; margaritâ albâ et iridescente.

Shell subrotund, inequilateral, compressed, subangular behind, with oblique folds on the beaks; valves rather thick; beaks somewhat elevated and much plicate; epidermis dark brown; cardinal teeth large, elevated and lamelliform; lateral teeth nearly straight; nacre pearly white and iridescent.

Hab. River Parana, Province of Corrientes. Dr Burrough.
My Cabinet.
Cabinet of Dr Burrough.
Cabinet of the Academy of Natural Sciences of Philadelphia.

Diam. ·1, Length 1·8, Breadth 2·4 inches.

Shell subrotund, inequilateral, compressed, subangular behind, with large oblique folds on the beaks; substance of the shell rather thick; beaks somewhat elevated and distinctly plicate as far as the umbones; ligament short and thin; epidermis smooth, dark brown with transverse yellow marks of growth; cardinal teeth large, elevated, lamelliform and double in both valves; lateral teeth lamelliform and nearly straight; anterior cicatrices and posterior cicatrices confluent; dorsal cicatrices in the centre of the cavity of the beaks; cavity of the beaks subangular and shallow; nacre pearly white and iridescent.

Remarks.—This is of the collection of Dr Burrough, sent by him to the Academy of Natural Sciences of Philadelphia. To this gentleman natural science is much indebted for his unwearied industry in contributing to the knowledge of the Fauna—of the numerous countries through which he has travelled, in Asia, as well as on this continent. This species resembles most, perhaps, the *lacteolus* (nobis), but differs from it in being more round in the outline, in having longer and larger folds on the beaks, and in being more compressed. In the beaks it has some resemblance to the *corrugatus* (Lam.), as well also as in the outline; but the folds being nearly parallel to each other, it differs from the *corrugatus* in these, which are usually zig zag in the latter shell. I owe to the kindness of Dr Burrough the specimen in my cabinet, and I have great pleasure in dedicating the species to him.

Unio Sowerbianus. Plate X. fig. 28.

Testâ subtriangulari, inflatâ, parte posticâ peculiariter compressâ et striatâ; valvulis crassissimis; natibus valde prominentibus, dentibus cardinalibus magnis; lateralibus crassis subrectisque; margaritâ in cavo albido-purpureâ.

Shell subtriangular, inflated, singularly compressed on the posterior part, which is striate ; valves remarkably thick ; beaks very prominent ; cardinal teeth large ; lateral teeth thick and nearly straight ; nacre in the cavity very light purple.

Hab. Tennessee. G. B. Sowerby.
My Cabinet.
Cabinet of Mr Sowerby.

Diam. 1·5, Length 1·7, Breadth 1·8 inches.

Shell subtriangular, inflated, singularly compressed on the posterior part, which is filled with striæ passing from the beak to the posterior and posterior-basal margins, the anterior part being inflated and smooth; slightly emarginate at posterior basal margin; substance of the shell very remarkably thick, less so on the posterior part; beaks large and very prominent; ligament short and thick; epidermis bright brown, smooth and shining before, striate behind; cardinal teeth large, sulcate, elevated and cleft in the left valve, and emerging from a pit in the right valve; lateral teeth thick, short and nearly straight; anterior and posterior cicatrices both distinct; dorsal cicatrices situated on the under part of the cardinal teeth; cavity of the beaks shallow and subangular; nacre very light purple in the cavity, and white on the anterior margin.

Remarks.—To the kindness of G. B. Sowerby, Esq., one of the most distinguished writers on conchology in England, I owe the possession of this truly interesting shell, and to him I with great pleasure dedicate it. He received it from the state of Tennessee, but from what river I do not know. In general outline it resembles somewhat the *trigonus* (nobis), but differs from it in being more rotund, in having the posterior part compressed and striate, and in being coloured inside. It has a stronger resemblance to the *Haysianus* (nobis) than to any other species known to me, but differs from it in being more compressed behind, in being more striate, in being much larger (to judge from the few specimens I have seen of both), and in the difference of the colour of the nacre, the *Haysianus* being dark chocolate, while the *Sowerbianus* is of a very light purple, approaching to flesh colour.

Unio dromas. Plate X. fig. 29.

Testâ subtriangulari, subobliquâ, gibbâ, irregulariter transversimque plicatâ, punctiunculis passim radiatâ; valvulis crassissimis; natibus prominentibus; dentibus cardinalibus latis, lateralibus crassis brevibusque; margaritâ albâ.

Shell subtriangular, somewhat oblique, hunch-backed, irregularly and transversely folded, with dotted rays over the whole disk; valves very thick; beaks elevated; cardinal teeth wide; lateral teeth short and thick; nacre pearly white.

Hab. Harpeth River, Tennessee. Professor Conrad.
Hab. Cumberland River, near Nashville. Professor Troost.
My Cabinet.
Cabinet of the Academy of Natural Sciences of Philadelphia.
Cabinet of Professor Troost.
Cabinet of P. H. Nicklin.

Diam 1·6, Length 1·8, Breadth 1·9 inches.

Shell subtriangular, somewhat oblique, hunch-backed, irregularly and transversely folded at the separate stages of growth, furnished with an oblique furrow before the umbonial slope, substance of the shell very thick; beaks thick and elevated; ligament short, thick and dark coloured; umbones furnished with a hump; epidermis yellow, with numerous dark green dotted rays, on the anterior part furnished with about six somewhat broad rays; cardinal tooth wide and sulcate; lateral tooth short and thick, having a flat plate between it and the cardinal tooth; anterior and posterior cicatrices both distinct; dorsal cicatrices situated on the under side of the cardinal tooth; cavity of the beaks deep and angulated; nacre pearly white, on the posterior part sometimes golden.

Remarks.—I have had for some years in my cabinet two specimens of this beautiful and curious species, the first of which, a young one, I owe to the kindness of the late professor Conrad. Having recently received a complete suite from professor Troost, I have perfectly satisfied myself of (what I before doubted) its being distinct from the *irroratus* (nobis). The manner in which the hump is formed is very remarkable. As far as the third or fourth stage of growth the disks are almost flat. The deposit of the nacre after this forms an angle of nearly 45° with the surface which it has left, thus forming a hump, or obtuse angle point, directly on the umbo. This causes the curious result, that when the shell is from one third to three fourths grown, it will rest, when so placed, on the portion of surface between the point of the beak and the umbo, the basal margin remaining in the air. In its general characters it resembles the *irroratus*, but may at once be distinguished by the hump. It is devoid of tubercles, while the *irroratus* is sometimes covered with them, particularly on the posterior part. It differs somewhat also in the rays, the spots in those of the *dromas* being larger, and generally better defined. The outline differs in being less elongated, being disposed to be more oblique or more transverse. In regard to the structure of the animal, I am not prepared to say that it differs from that of the *irroratus*.* Not having had an opportunity to examine the animal, I can only judge by analogy, which would, I think, induce one to conclude that the same curious pendent oviducts would be found in both. I hope to be able to procure from professor Troost a specimen in that period of gestation.

UNIO TROOSTENSIS. Plate X. fig. 30.

Testâ scalenâ, cuneatâ, obliquâ, valde inæquilaterali; valvulis antice crassioribus; natibus subterminalibus; epidermide luteolâ, radiis capillaribus multis; dentibus cardinalibus elevatis, cristatis; lateralibus subrectis; margaritâ albâ et iridescente.

Shell scaleniform, wedge shaped, oblique, very inequilateral; valves thicker anteriorly; beaks nearly terminal; epidermis yellowish, filled with numerous capillary rays; cardinal teeth elevated, crested; lateral teeth nearly straight; nacre pearly white and iridescent.

Hab. Cumberland River. Professor Troost.
My Cabinet.
Cabinet of Professor Troost.

* See vol. iii. p. 271.

Diam. ·8, Length ·1, Breadth 1·9 inches.

Shell scaleniform, cuneated, oblique, very inequilateral, angular behind; substance of the shell thick before, thinner behind; beaks elevated and rounded; epidermis very finely wrinkled, shining, yellowish brown with numerous green flexuous capillary rays over the whole disk; ligament rather short and thick; cardinal teeth elevated, crenate, deeply cleft in the left valve, and emerging from a pit in the right valve; lateral teeth long and nearly straight; anterior cicatrices distinct; posterior cicatrices nearly distinct; dorsal cicatrices situated in the centre of the cavity of the beaks; cavity of the beaks very shallow; nacre beautifully pearly white and iridescent.

Remarks.—I owe to the great kindness of professor Troost the examination of his select specimens, which he most obligingly sent to me for that purpose. Among them were two specimens of this rare and beautiful species, unsurpassed by any other in the delicacy and exquisite beauty of its rays. In general form it approaches the *scalenius* (Rafinesque), but differs from it in the form of the rays altogether. It differs also in colour and in having the beaks less retuse. In dedicating this rare and beautiful species to my friend, professor Troost, I do him but an act of simple justice. His constant efforts in the promotion of the physical sciences are known and acknowledged, and his investigation in this branch of conchology will do much to illustrate its history in his adopted state.

Unio perdix. Plate XI. fig. 31.

Testâ ellipticâ, postice subangulatâ, subæquilaterali, inflatâ, transversâ; valvulis subcrassis; epidermide luteolâ, radiis irregulariter interruptis; dentibus cardinalibus elevatis; lateralibus prope eorum fines majoribus; margaritâ albâ et iridescente.

Shell elliptical, subangular behind, nearly equilateral, inflated, transverse; valves rather thick; epidermis yellowish with irregularly interrupted rays; cardinal teeth elevated; lateral teeth larger near their termination; nacre pearly white and iridescent.

Hab. Harpeth River, Tennessee. Professor Troost.
My Cabinet.
Cabinet of Professor Troost, Nashville.

Diam. 1·4, Length 1·9, Breadth 3·1 inches.

Shell elliptical, subangular behind, nearly equilateral, inflated, transverse; substance of the shell rather thick; beaks slightly elevated and without undulations at tip; ligament short and thick; epidermis yellowish with irregularly interrupted rays over the whole disk; cardinal teeth elevated, double in the left valve and single in the right; lateral teeth enlarged and disposed to be bladed at the termination; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices situated along the base of the cardinal tooth and under the plate between the cardinal and lateral teeth; cavity of the beaks wide and obtusely angulate; nacre pearly white, extending only far enough to leave a broad horn coloured border.

Remarks.—This species was among the shells sent to me by professor Troost. To judge from the few specimens I have seen, I should suppose it varied much from age as well as locality. One of my specimens is old and very large, scarcely presenting a ray. In this state it closely resembles the *U. obovatus* (nobis), but is rather more transverse. The younger and more perfect specimens approach more closely to the *U. crassus* (Say), but are more inflated, and differ in the rays, which are broken into irregular spots, not entirely dissimilar to the plumage of the partridge. It has some resemblance to the *U. pictus* herein described, but is not compressed like that species, and differs in the rays. In some specimens the teeth are disposed to be pinkish.

Unio Pictus. Plate XI. fig. 32.

Testâ ellipticâ, compressâ, inæquilaterali; valvulis subtenuibus; natibus compressis et ad apices undulatis; epidermide luteâ, radiis tenebroso-viridibus interruptis; dentibus cardinalibus parvis; lateralibus longis et subcurvis; margaritâ albâ et iridescente.

Shell elliptical, compressed, inequilateral; valves rather thin; beaks compressed and undulated at tip; epidermis yellow with interrupted dark green rays; cardinal teeth small; lateral teeth long and slightly curved; nacre pearly white and iridescent.

Hab. Harpeth River, Tennessee. Professor Troost.
My Cabinet.
Cabinet of Professor Troost.

Diam. ·8, Length 1·6, Breadth 2·6 inches.

Shell elliptical, compressed, inequilateral; substance of the shell rather thin, thicker before; beaks compressed and finely undulated at the tip; ligament short and rather thick; epidermis fine yellow with numerous oblique interrupted rays, which are strongly pencilled at the commencement of each stage of growth; cardinal teeth very small and erect; lateral teeth long and slightly curved, in the left valve enlarged near the termination; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices in the centre of the cavity of the beaks and deeply impressed; cavity of the beaks very shallow and rounded; nacre pearly white and iridescent.

Remarks.—This species, so beautiful and so peculiar in its painted exterior, I owe to the kindness of professor Troost. The fine specimen figured belongs to the museum of that gentleman in Nashville, and I am indebted to him for the loan of it to insert it here. It belongs to a group, the peculiar character of which seems to be in the singular interruption of the rays, which are obsolete, except at the commencement of each stage of growth, where they are strongly pencilled with green. The *U. planulatus* (nobis), *U. patulus* (nobis) and *U. perdix* (herein described) belong to this group. The *U. pictus* has some resemblance to the *U. cariosus* (Say), but differs in being more compressed, and in having rays over the whole disk. It perhaps more closely resembles the younger specimens of *U. crassus* (Say). It differs, however, in being thinner, smaller, and in the character of the rays.

SYMPHYNOTA DISCOIDEA. Plate XI. fig. 33.

Testâ subrhombeâ, compressâ, transversâ, inæquilaterali, valvulis tenuissimis, postice connatis; natibus paulum undulatis, compressis; dentibus in valvulâ utrâque lineam simplicem facientibus; margaritâ albâ et iridescente.

Shell subrhomboidal, compressed, transverse, inequilateral; valves very thin, connate behind; beaks slightly undulated, compressed; teeth in both valves forming a simple line; nacre white and iridescent.

Hab. . . . . * G. B. Sowerby.
My Cabinet.
Cabinet of Dr Burrough.
Cabinet of W. Hyde.

Diam. 1·2, Length 2·4, Breadth 3·9 inches.

Shell subrhomboidal, compressed, transverse, inequilateral, finely wrinkled; substance of the shell very thin; posterior slope elevated into a moderately high wing, which is connate; beaks very slightly undulated, compressed; ligament linear; epidermis dark brown; teeth in both valves forming a simple, continuous, fine curve line; anterior and posterior cicatrices both distinct; dorsal cicatrices situated in the centre of the cavity of the beaks; cavity of the beaks almost none; nacre white and iridescent.

Remarks.—I owe to the kindness of G. B. Sowerby, Esq. the specimen here described. He procured it of "a dealer from Holland," and its habitat is unknown. It has the characters of an eastern shell, and probably came from Java. In the outline of the margin it resembles the *Symphynota magnifica* (described in this memoir), but differs from it in being compressed and in the possession of teeth. In the teeth it has a stronger resemblance to the *S. bialata* (nobis) than to any other species. It is, however, less defined, and the curve is less regular, the posterior portion being nearly straight. In the elevation of the wing it differs totally. Our present shell forms an interesting

* Dr Burrough has recently obtained it in the rivers of China, and to him I owe the fine specimen figured.

link in the gradual change of the characters of the teeth. It approaches that division of the *Naïades* which do not possess teeth, more closely than any species which has come under my notice.

ANODONTA LATO-MARGINATA. Plate XII. fig. 34.

Testâ obovatâ, transversâ, inæquilaterali; intus margine latâ et corneâ; sinu longo et in partem internam disci vergente; valvulis crassis; epidermide rubido-fuscâ; margaritâ albâ et iridescente.

Shell obovate, transverse, inequilateral, interior with a broad horn coloured border; sinus long, and pointed towards the interior of the disk; valves thick; epidermis reddish brown; nacre pearly white and iridescent.

Hab. River Parana, South America. Dr Burrough.
My Cabinet.
Cabinet of the Academy of Natural Sciences of Philadelphia.
Diam. 1·5, Length 2·5, Breadth 3·5 inches.

Shell obovate, transverse, inequilateral, inflated, interior with a broad horn coloured border; sinus long, and pointed to the interior of the disk; substance of the shell thick; beaks somewhat elevated; ligament long and thick; epidermis reddish brown, finely wrinkled, and sometimes obscurely rayed; anterior cicatrices distinct; posterior cicatrices confluent; palleal cicatrices almost imperceptible; dorsal cicatrices apparently none; cavity of the beaks shallow and subangular; nacre pearly white and iridescent, extending only to the broad horn coloured border.

Remarks.—In the collection of Dr Burrough there are several specimens of this species, some of which are young and more rotund than that figured here. It presents several characters unusual in the species of this genus, so far as our knowledge extends. The horn coloured border is even broader than that of the *tenebricosa* herein described, and the apparent absence of the dorsal cicatrices I have never noticed before in any species of the family. The sinus of this species is very remarkable, as well as that of the *tenebricosa*. It does not, however, like that species, curve towards the cavity of the beaks; it stretches in a point towards the centre of the cavity of the disk. In general outline it resembles the *An. Patagonia* (Lam.), but differs in being less rotund, less inflated, and in the nacre being white.

Anodonta Blainvilliana. Plate XII. fig. 35.

Testâ ovatâ, inflatâ, valde inæquilaterali, antice angulatâ, postice latissimâ, ad marginem anteriorem hianti; cicatrice marginali latâ et postice valde incurvâ; valvulis subcrassis; natibus prominulis; margine dorsali rectâ; margaritâ salmonis colore tinctâ.

Shell ovate, inflated, very inequilateral, angular before, very wide posteriorly, gaping at the anterior and posterior margins; palleal cicatrix broad and much incurved posteriorly; valves rather thick; beaks somewhat prominent; dorsal line straight; nacre salmon and pearly.

Hab. Chili?

My Cabinet.

Diam. 1·3, Length 1·9, Breadth 3 inches.

Shell ovate, inflated, very inequilateral, angular before, very wide posteriorly, the greatest length being perpendicular from the extreme posterior end of the ligament to the basal margin, gaping much at the anterior margin, and rather less at the posterior margin; substance of the shell somewhat thick; beaks rather prominent; dorsal line straight, having a slight elevation under the beak like an incipient tooth; anterior cicatrices complicated but distinct; posterior cicatrices wide and confluent; dorsal cicatrices numerous and stretched in a line across the cavity of the beaks; marginal cicatrix wide, deep and much incurved near to the posterior cicatrix; nacre salmon, beautifully pearly and iridescent.

Remarks.—I accidentally met with this interesting shell at a shop in Havre last October, a few days previously tô my embarkation. The two valves belong to different individuals, but they very nearly match. They have both been slightly mutilated by an attempt to *beautify* them, the epidermis having been almost completely removed. What remains indicates it to be greenish, and is sufficient to warrant its being represented in the figure with a perfect epidermis—the ligament has also been destroyed. I was informed by the dealer that it came from Chili; such authority cannot, however, be entirely relied on. The cicatrices of this interesting species are very remarkable, particularly that of the mantle near the margin; the palleal impression is wide, deeply impressed, and in the posterior part of the shell deflected towards the centre of the cavity, somewhat similar to the excavation of the palleal cicatrix of the genera *Galathea* and *Mactra*. The character of this cicatrix is different from that of any species of the family *Naïades* I have seen, and this peculiarity induces me to believe that the animal, when found, may prove to be different from that of the *Anodonta*. Should this be the case, it will belong of course to a new genus, for which I propose the name of *Columba*. It somewhat resembles the *An. exotica* (Lam.). It is, however, narrower before and broader behind than that shell. It gapes anteriorly and posteriorly more than any of the *Naïades* with which I am acquainted. It is perhaps most nearly allied to the *Anodon crassus* (Swainson), but differs in the dorsal line being straight, the nacre being pearly salmon, as well also in the peculiar character of the palleal cicatrix.

Anodonta tenebricosa. Plate XII. fig. 36.

Testâ ellipticâ, transversâ, inæquilaterâ, intus margine latâ et corneâ; sinu incurvo; valvulis crassis; epidermide tenebroso fuscâ; margaritâ albâ subcæruleâ purpurâ nubilâ, iridescente.

Shell elliptical, transverse, inequilateral, interior with a broad horn coloured border; sinus incurved; valves thick; epidermis dark brown; nacre pearly white, clouded with bluish purple, iridescent.

Hab. River Parana, South America. Dr Burrough.
My Cabinet.
Cabinet of Dr Burrough.
Cabinet of the Academy of Natural Sciences of Philadelphia.

Diam. 1·5, Length 1·9, Breadth 3·3 inches.

Shell elliptical, transverse, inequilateral, with a broad horn coloured border, emarginate at base; sinus incurved; substance of the shell thick; beaks scarcely prominent; ligament long and thick; epidermis dark olive brown, wrinkled, obscurely rayed on the posterior slope; anterior cicatrices distinct; posterior cicatrices confluent; palleal cicatrix large and partially tinted with bluish purple; dorsal cicatrix situated in the centre of the cavity of the beaks; cavity of the beaks very shallow; nacre pearly white clouded with bluish purple, extending only to the broad horn coloured border, iridescent.

Remarks.—This curious species is from the collection sent to the Academy of Natural Sciences by Dr Burrough. It differs distinctly from any species known to me. The horn coloured broad border, and the absence of nacreous matter on this part is very remarkable, as is also the close approximation to a perfect ellipsis, the posterior and anterior margins being nearly of the same curve. The clouded bluish purple colour I have never seen in the nacre of any other species. The sinus is so peculiar in the two specimens examined, that I would impress it as important in the character of this species. In the *An. exotica* (Lam.), a South American species, the sinus is generally of the form of an equilateral triangle, the inferior angle being sharp and well defined. In the present species the sinus is still more remarkable, curving in towards the cavity of the beak and terminating with quite an acute angle. The line of the opening of the two specimens is curved and not a plane, as usual with the *Naïades;* and the right beak and margin anterior to it, overwrap in a small degree the left beak and valve. In the old specimen this extension of the margin passes the other more than an eighth of an inch—consequently the shell might almost be said to be inequivalve. In its general characters this species most resembles the *sinuosa* of Lamarck.

ANODONTA MORTONIANA. Plate XIII. fig. 37.

Testâ subellipticâ, postice sub-biangulatâ, transversâ, valde inæquilaterali ; valvulis crassis ; epidermide perfuscâ ; clivo umboniali sulcato ; margaritâ argenteâ et iridescenti.

Shell subelliptical, sub-biangular behind, transverse, very inequilateral ; valves thick ; epidermis intensely brown ; umbonial slope furrowed ; nacre silvery and iridescent.

Hab. River Parana, South America. Dr Burrough.
Cabinet of the Academy of Natural Sciences of Philadelphia.
Cabinet of Dr Burrough.

Diam. 1·2, Length 1·6, Breadth 3 inches.

Shell subelliptical, sub-biangulate behind; transverse, very inequilateral, somewhat inflated, furrowed from the beak to the posterior margin along the umbonial slope; substance of the shell thick; beaks retuse and scarcely prominent; ligament long and narrow; epidermis intensely brown and finely wrinkled; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices apparently none; cavity of the beaks subangular and shallow; nacre silvery white and iridescent.

Remarks.—A single specimen of this species, which is distinct from any described *Anodonta* I have seen, was sent to the Academy by Dr Burrough. It is remarkably thick, silvery and iridescent, and has an exceedingly dark epidermis. It most resembles, perhaps, the *elongatus* of Swainson. It is less transverse than that shell, rounded only anteriorly; it differs in not having "a strong flesh coloured tinge," and is by no means so bright a brown as his beautiful figure.

Named after S. G. Morton, M.D., corresponding secretary of the Academy of Natural Sciences of Philadelphia.

Melania aculeus. Plate XIX. fig. 72.

Testâ acuto-elevatâ, lævissimâ, tenebroso-corneâ; apice acutissimo; anfractibus circiter duodecim, subconvexis; labro expasso.

Shell acutely elevated, very smooth, dark horn colour; apex very acute; whorls about twelve, somewhat convex; labrum spread out.

Hab. Java?

My Cabinet.

Diam ·6, Length 2 inches.

Remarks.—I purchased this, with some other of the shells described in this memoir, from the collection brought from Java by Mr Shillaber. It is remarkable for its attenuated form and tapering spire. It is more than usually spread out at the base. The substance of the shell is thin and bluish white. The last whorl is much enlarged. The aperture occupies about one-third of the length of the shell.

Lymnæa imperialis. Plate XIX. fig. 73.

Testâ ovato-ventricosâ, pellucidâ, tenuissimâ, albido-corneâ, subcoronatâ; apice obtuso; anfractibus quaternis, inflatis, ultimo maximo; aperturâ magnâ, ovatâ; labro valde extenso.

Shell ovato-ventricose, diaphanous, very thin, light horn colour, subcoronate; apex obtuse; whorls four, inflated, the last very large; aperture large, ovate; outer lip much extended.

Hab. South America?

My Cabinet.

Diam. ·9, Length 1·4 inches.

Remarks.—I accidentally met with this rare and interesting shell at a dealer's in Paris. I saw no other specimen in any of the great collections in Europe. The person from whom I obtained it informed me it came from South America. It is more inflated than any species with which I am acquainted; but what eminently distinguishes it is the subcoronate apex which, as far as we yet know, is peculiar to this species. The body whorl nearly envelopes the superior ones. When examined by the microscope, transverse striæ are observed to cause numerous minute depressions on its surface.

MELANOPSIS PRINCEPS. Plate XIX. fig. 74.

Testâ acuto-elevatâ, lævi, rufo-fuscâ, obsolete multimaculatâ; inferiori anfractu carinato, dimidio basali transversim striato; apice acuto; anfractibus plus minus quatuordecim, planis; aperturâ quintâ parte testæ.

Shell acutely elevated, smooth, transversely striate on the lower half of the body whorl, which is carinate, reddish brown, with numerous indistinct spots; apex acute; whorls about fourteen, flat aperture one-fifth the length of the shell.

Hab. Cape of Good Hope.

My Cabinet.

Diam. ·6, Length 2·1 inches.

Remarks.—This is the most remarkable species of the genus which I have examined. It differs from any described species in its great elevation, in the flatness of its whorls, in its being covered with indistinct spots, and in the absence of a large callus on the superior part of the inner lip, as well also as in the great number of its whorls. The spots are peculiar in being chain-like, alternately darker and lighter. The operculum is horny, like that of the genus *Melania.*

MELANOPSIS MACULATA. Plate XIX. fig. 75.

Testâ fusiformi, tenebroso-olivaceâ, intus fasciatâ; epidermide maculatâ; anfractibus quaternis; basi subtruncatâ; columellâ sine callo superno.

Shell fusiform, dark olive, banded on the inside, and spotted in the epidermis; whorls four; base but slightly truncate; columella not thickened above.

Hab. Peru. Lieutenant Humphreys.

My Cabinet.

Cabinet of the Academy of Natural Sciences of Philadelphia.

Diam. ·3, Length ·5 inches.

Remarks.—The genus *Melanopsis*, a few years since, presented, to our knowledge, only two species. These were described by Lamarck. The rapid advancement of our science has recently brought to light many new ones. I have eight species in my own cabinet, and in this memoir I add two species to the ten now known. These two are peculiarly and beautifully spotted in the epidermis. The two specimens brought by lieutenant Humphreys have each four transverse purple bands on the inside, and the dark olive epidermis is filled with very distinct intensely dark brown quadrate spots. This species, and the *princeps* herein described, form a division in the genus *Melanopsis* of Lamarck which genus should be altered, leaving out the character of the callus on the upper part of the columella. Neither of these has that character, but, notwithstanding, should not be removed to a new genus, as it is, independent of that, a perfectly natural one.

AURICULA FUSCAGULA. Plate XIX. fig. 76.

Testâ fusiformi, albidâ, pellucidâ; suturis impressis et albo-lineatis; labro late reflexo; gulâ fuscâ et dentibus novenis munitâ.

Shell fusiform, whitish, diaphanous; sutures impressed and presenting a white line; outer lip widely reflected; throat dark brown and furnished with nine teeth.

Hab. Brazil.

My Cabinet.

Cabinet of P. H. Nicklin.

Diam. ·4, Length 1·1 inches.

Remarks.—This is a very remarkable and interesting species. In its general form and aperture it resembles a *Clausilia.* Like some species of that genus its mouth is studded with teeth. Of the nine, seven are on the outer lip—the last of these and the first on the columella are the largest. The deep brown of the throat is visible through the shell. In some specimens there is a finely mottled appearance over the lower whorls of the shell. The white line along the suture is placed on the upper part of the whorl. The outline of the shell is remarkably fusiform.

Cyclostoma striata. Plate XIX. fig. 77.

Testâ depressâ, planulatâ, multistriatâ, albâ, pellucidâ, latissime umbilicatâ; anfractibus quaternis; apice acuminato, rufo; labro acuto; operculo corneo tenuique.

Shell depressed, flattened, much striate, white, translucent, very widely umbilicate; whorls four; apex red and pointed; lip sharp; operculum thin and horny.

Hab. Peru. Lieutenant Humphreys.

Cabinet of the Academy of Natural Sciences of Philadelphia.

Diam. ·9, Length ·5 of an inch.

Remarks.—This shell was brought by lieutenant Humphreys from South America, and presented, with many other fine specimens, to the Academy. It resembles the *C. Jamaicensis* (Fer.); but is much larger, and has finer striæ. The rotundity of the mouth is slightly modified by the junction of the superior part with the columella.

Achatina Vanuxemensis. Plate XIX. fig. 78.

Testâ fusiformi, tenui, pellucidâ, longitudinaliter et transversim striatâ, luteâ, in anfractum infernum obsolete albo-maculatâ; suturis granulatis; canali baseos curvo.

Shell fusiform, thin, pellucid, longitudinally and transversely striate, ochre coloured, with indistinct white spots on the body whorl; sutures granulate; channel curved at the base.

Hab. Mexico. Professor Vanuxem.
My Cabinet.
Cabinet of Professor Vanuxem.
Cabinet of the Academy of Natural Sciences of Philadelphia.
Cabinet of P. H. Nicklin.
Diam. 1·2, Length 2·5 inches.

Remarks.—Among the shells brought from Mexico by professor Vanuxem, was this fine *Achatina*, which belongs to Lamarck's second division of this genus. It very closely resembles the *Buccinum striatum* (Chem.), *Polyphemus glans** (Say), *Glandina* (Say). It differs from it in having crenulated sutures, and in having fine transverse lines, as well as longitudinal striæ. The indistinct opake white spots, which are more frequent on the front of the body whorl, are, I believe, peculiar to this species. It is larger by one-third than any individual of the *striata* which I have seen.

In concluding these descriptions and observations, I will take advantage of the opportunity to express my thanks to those gentlemen who have kindly assisted me with new shells and rendered other friendly offices. Among these I have been particularly obliged by Philip H. Nicklin, Esq., William Cooper, Esq. and professor Troost. To the Academy of Natural Sciences of Philadelphia an acknowledgement is due, for the liberal and unhesitating vote which it passed, to permit me to describe for our Transactions the new species in their splendid and highly useful collection.

I will take this opportunity also to correct the habitat of the *Unio brevidens* (Vol. IV. page 75), which professor Troost thinks has not been found in the Ohio, but only in the Cumberland. The specimen which Mr Cooper kindly gave to me to be described, came, I believe, originally from professor Troost. The specimen figured was not more than half grown. The older individuals usually have an arched ridge along the

* *Cochlicopa rosea* (Fer.). It should now be called *Achatina striata*, unless the generic name be changed, the propriety of which I doubt.

umbonial slope near to the margin, the edges of each growth being there dentate. In some specimens this is so strongly marked as to resemble a thick cord. The *Arcæformis*, professor T. doubts being in Tennessee river. He found it only in the Cumberland. He was, I believe, the first person who sent this species to New York and this city. Some fine old specimens, recently received from that gentleman, exhibit a diameter of a most extraordinary nature, as well also an almost perfect flatness of the posterior slope. My oldest specimen, when placed on a plane, will rest both on the base and on that slope. The specimen figured by me, was not more than two-thirds grown, and was then the best specimen I had seen, and I supposed it to be an adult.

OBSERVATIONS ON LAMARCK'S NAIADES.

Having had the opportunity while in Paris recently, to inspect most of the cabinets to which Lamarck refers in his description of the *Naïades*, I seized the opportunity to examine the *individual specimens* from which he made his descriptions; and having made notes on the spot, I feel great confidence as to the facts, and trust that my judgment as to the decisions on his species will be found to be correct.

In pointing out the errors of this great zoologist, we must not be astonished at their number, nor should the slightest shadow fall upon his merited and exalted reputation. We should rather think of the means within his power, the poverty of the materials with which he worked, and above all, the unfortunate ophthalmia which afflicted his declining years, and which he deplores in the advertisement of the sixth volume of his Hist. Nat. des Animaux sans Vertèbres.

Unio sinuata. This is a true species, but Klein is entitled to the name which he gave first to it, viz. *crassissima.** It has been considered by the conchologists of this country (and I certainly was of the

* See Transactions of the Linnean Society of Bourdeaux, Vol. II. p. 42.

same opinion) to be the *Mya margaritifera* of Linnæus. It has all the characters of this species, with the exception of the addition of the thick lateral tooth, which our author does not describe, but could scarcely have failed to have observed. Being possessed of this tooth, it is of course a true *Unio*. Pfeiffer describes an old *margaritifera* under the name of *sinuata*. He says "dente cardinali valido, subconico, laterali nullo." In the north of Europe, (for the *sinuata* exists only in the south) he had not, perhaps, like ourselves, until recently, an opportunity of examining the true *sinuata* of Lamarck.

Unio elongata. This is the true *Mya margaritifera* of Linnæus and other authors. The *Alasmodonta arcuata* of Barnes is its analogue in this country. It inhabits the north of Europe, lake Ladoga, Norway, &c.

Unio crassidens. The specimen quoted from Lamarck's own collection, which is now in the possession of the Duke de Rivoli, is the *cuneatus* of Barnes. Var. *a* is the *trapezoides* (nobis), a shell very different in its general characters, being always folded. *Crassidens* therefore has precedence of *cuneatus*.

Unio Peruviana. This is the *plicatus* of Le Sueur, now so well known in all our collections. Valenciennes says, Dombey's shell remains in the museum, and that Lamarck described a North American shell in error. The figure referred to by Lamarck, in the Ency. Methodique, is certainly the well known *plicatus* of our western waters.

Unio purpurata. Lamarck supposed the specimens he examined to have come from Africa. I examined the specimen cited, in the Duke de Rivoli's collection, as well, also, one in that of Baron de Ferussac. These specimens have been polished, and have, most probably, been in the cabinet of Paris for twenty or thirty years; for, few *Uniones* were admitted into the cabinet, at that time, without the loss of their superficial protection. It is the *ater* (nobis), and, most probably, was taken from the neighbourhood of New Orleans, while in possession of the French. The specimen described and figured in one of my former memoirs, came from Port Gibson, below Natchez; and I subsequently received some from the vicinity of New Orleans and from Claiborne, Alabama. I therefore, willingly yield the name to Lamarck.*

* In the "American Conchology," No. V., Mr Say re-describes and re-figures the *Unio*

Unio ligàmentina. The specimen in the Garden of Plants is the *U. crassus* of Say.

Unio obliqua, in the same collection is the *U. undatus* of Barnes.

Unio retusa. This is the *U. torsus* (Rafinesque). The locality given is Nova Scotia; the correctness of which I doubt much. It is, as yet, known to exist only in our western waters.

Unio rarisulcata. The specimen in the Garden of Plants is the *complanatus* (Soland.), *purpureus* of Say.

Unio coarctata. The specimen in the collection of the Duke de Rivoli is the *complanatus* (Soland.). The observation of Lamarck, that "it is the analogue of our *U. margaritifera*," (he ought to have said *elongata*, for he does not use the name of *margaritifera*) must be an error. The American shell, described by Barnes as *Alasmodonta arcuata*, is the unquestionable analogue of the true *Mya margaritifera* (Linn.), and a very different shell, not having a lateral tooth, and belonging to Schumacker's genus *Margaritana* (Say's *Alasmodonta*).

Unio purpurascens. This is also a *complanatus*, in the museum of the Garden of Plants.

Unio radiata. The specimen at the Garden of Plants is the true *radiatus.* The *Unio ochraceus* (Say), given as a synonyme, is a very distinct species.

Unio brevialis. The specimen at the Garden of Plants resembles so closely the *U. littoralis*, that I am induced to believe it never came from the Isle of France, and that it is of European origin. That in Baron de Ferussac's cabinet is certainly an old *littoralis.* The shell figured by Crouch, under the name *brevialis*, is entirely distinct.

Unio rhombula. The specimen now in the cabinet of the Duke de Rivoli* is a young and bad specimen of the *complanatus*, and certainly from the United States, and not Senegal. Var. *b*, in the cabinet of Valenciennes, I did not see.

ater, under the name of *U. lugubris*, alleging that the name *ater* is "preoccupied by Nilsson for a very distinct species." Mr S. does not seem to be aware, that Nilsson's *ater* is only a variety of *U. Batava*, of Maton and Racket; and, therefore, could not affect my claim. We must both yield to the prior claim of Lamarck.

* I ought to say that the Duke keeps the cabinet of Lamarck intact, as much as possible, and, therefore, the shells quoted may be relied on as being the same as described by Lamarck.

Unio carinifera is also the *complanatus*, which inhabits so large a space of our country east and west of the Alleghany mountains.

Unio Georgina is also from the mine *complanatus*.

Unio clava. This is the *scalenia* of Rafinesque: *modioliformis* of Say.

Unio recta is Barnes's *prælongus*. Lamarck has precedence.

Unio naviformis. This is the *cylindricus* of Say, who has precedence.

Unio glabrata. This is the *complanatus*. The specimen in the Duke de Rivoli's cabinet is most likely from our eastern waters.

Unio nasuta. The specimen from which this description was made, is now in the museum of the Garden of Plants. It is a young *gibbosus* of Barnes. It is not the same with Say's *nasutus*, as Lamarck suspected it to be. As Lamarck described the shell before Barnes, he has a claim for the species; but having used a name pre-occupied by another shell, he loses it. I therefore would continue Mr Barnes's name *gibbosus*.

Unio ovata is the *ovatus* of Say. Var. *b*, I was not enabled to see —from the description I presume it to be a variety of *occidens* (nobis).

Unio rotundata. The specimen shown to me by Baron de Ferussac, whose cabinet is cited for one of the two specimens seen by Lamarck, is a small *suborbiculata* (Lam.), a large specimen of which the baron had the goodness to give me, and I have reason to believe it to be the individual cited by Lamarck. It is the *subglobosus* (nobis), and the *glebulus* of Say.

Unio littoralis. This interesting species inhabits most parts of Europe. It has been brought also from the Tigris by some of the French scientific expeditions, and I owe to the kindness of the administration of the Garden of Plants a fine specimen from Bagdad. The specimens from this locality are less transverse, and Lamarck considered the difference sufficient to found a species, *semirugata*, by which name they are labelled in that institution. After examining carefully suites from Europe and Asia with Baron de Ferussac, he accorded with me in opinion, that there was not sufficient difference to warrant their separation.

After examining numerous specimens in Europe of the *littoralis*, I have strong doubts if the shell described by me in a former memoir, under the name of *incurvus*, be not a peculiar variety of it. It certainly has a marked similarity to a fine transverse specimen of *littoralis*. The specimen from which my description was made, was sent to me as a "non descript from Gibraltar," by Mrs Mawe. I had not at that time seen very fine specimens of the *littoralis*, and it did not strike me that there was a similarity to such as I had. While in London, that excellent conchologist, Mr G. B. Sowerby, showed me a specimen precisely similar to mine, and which I think he informed me was from the collection of the veteran Humphreys. In one valve was marked in ink "Brazil;" in the other the name of the person who is supposed to have brought it from that country.

Unio semirugata. The specimen which I examined in the Duke de Rivoli's cabinet, is the one mentioned as being in Lamarck's own cabinet. It is a young *littoralis*, with rather more undulations than usual.

Unio nana. I saw this species only in the collection of Baron de Ferussac. All the specimens were old and depauperated, and their similarity to *littoralis* so great, as to induce me to believe that when better individuals are procured, they will easily be referred to that species.

Unio delodonta. The specimen cited, and which I examined in the cabinet of the Duke de Rivoli, I suspect to be the *lacteolus* (nobis). It has the beaks eroded, and therefore does not present the peculiar character of radiating folds at the point of the beaks, which is consequently omitted in Lamarck's description.

Unio sulcidens. In the Duke de Rivoli's collection—it is a compressed *complanatus* (Soland.), from the Connecticut River, where this species is more disposed to assume that character than in any river in the United States with which I am acquainted.

Unio rostrata. This is one of the numerous species made from the *pictorum* of authors. It is merely an elongated variety of that species in all the cabinets where I have seen it in Europe.

Unio Batava. This is a distinct species from *pictorum.* Baron de Ferussac thinks that Maton and Racket are entitled to the species.

Lamarck cites Schroeter first. I have not an opportunity to examine Schroeter's work.

Unio nodulosa. This is a young individual of the *ovata* of Donovan, and no doubt the specimen cited never was out of Europe. The *ovata* is emphatically an European shell, and has served, like the *pictorum*, to which it has some resemblance, to make numerous species. Lamarck's habitat (lake Champlain) is certainly an error.

Unio varicosa. The specimen described by Lamarck is still in his original cabinet. It is a young and bad specimen of the *Alasmodonta marginata* (Say). From the description I formerly supposed it to be *Alas. undulata* (Say).

Unio granosa. The only specimen of this beautiful and distinct species I saw in Europe, is in the Garden of Plants. It is unique in the possession of disks completely covered with minute granular elevations.

Unio depressa. The specimen in the Duke de Rivoli's collection is marked "from Peru," and is a very different species from one which I procured in Paris, marked by Lesson as *depressa* from New Holland. Lamarck's description is so extremely vague, that it almost equally well applies to both. The shell from Peru, of which I have several specimens, is more transverse than that from New Holland, which I presume should be considered the true *depressa.*

Unio Virginiana. This is a bad specimen of *radiatus*, in the Duke de Rivoli's collection.

Unio luteola. From the description and locality, I formerly supposed this to be Say's *cariosus.* On examining the specimen at the Garden of Plants, cited by Lamarck, I found it to be a true *siliquoideus* of Barnes, which sometimes approaches the *cariosus.* There must be an error in the locality given by Lamarck, as this species does not inhabit the waters east of the Alleghany mountains. Lamarck's name has precedence to that of Mr Barnes.

Unio angusta. This is a distinct and interesting species. Its habitat is unknown, and the only specimen I have seen is in the collection at the Garden of Plants.

Unio manca. I examined the original specimen in the cabinet of

Baron de Ferussac, which Lamarck described, and I convinced the Baron that it was only a *pictorum*.

Unio cariosa. The two specimens described are both in the cabinet of the Duke de Rivoli. The first is a bad specimen of Say's *cariosus*. The other (Var. 2) is a bad specimen of the *Alasmodonta marginata* (Say). One of the habitats, Lake Erie, is an error; it is found only in our waters east of the Alleghany mountains.

Unio spuria. This species is mentioned by Lamarck as being in the museum of the Garden of Plants. I did not see it there, nor do I know it to be in any other collection.

Unio australis. The same remarks apply to this species.

Unio anodontina. I examined the individual described under this name in the collection of the Duke de Rivoli. It proved to be a specimen of *U. marginalis*, which species is yet known to inhabit only the fresh waters of India. Lamarck says it comes from Virginia, which is certainly an error.

Unio suborbiculata. This is only a *rotundata*, as mentioned before in my observations on that species.

Hyria avicularis. This is the *Mya syrmatophora* of Gronovius, Gmel., Dill., &c.: *avicularis* should therefore be abandoned. Lamarck is not certain of the habitat of his specimen, but believes it to be from Brazil. I have seen in Paris a specimen brought by Spix from that country.*

Hyria corrugata is remarkable for the folds on the umbones, and is a very distinct species.—They are both in my cabinet.

Anodonta cygnea. The well known *Mytilus cygneus* of Linnæus and others. Of the various forms of this there have been created perhaps a dozen different species.

Anodonta anatina resembles very closely the *cygnea*, but is most probably a distinct species. Poiret asserts that this species is ovipa-

* This traveller brought also the *Castalia ambigua*, which, Lamarck says, seems to be fluviatile, but which he nevertheless separates from the *Naïades*, to which it naturally belongs, and not to the family *Trigoniana*. Both the shells are figured in Spix's beautiful work, but described with too little attention to previous writers.

rous, while the *cygnea* is viviparous. Should this prove true, they must of course be considered distinct.

Anodonta sulcata. I saw in the Duke de Rivoli's cabinet the specimen described by Lamarck. It is a variety of the *A. cygnea*, and I presume is from Europe. The *cygnea* has no analogue in the United States, with which I am acquainted.

Anodonta fragilis. Baron de Ferussac gave me a specimen of this species, brought by Monsieur Lapylaie from Newfoundland. When I first saw it in Paris, I recognized it instantly to be similar to specimens I had found in lake Skaneateles, nearly six years since, but which I had not yet published.

Anodonta rubens. This interesting species is perhaps the most ponderous of the genus. It inhabits the Nile as well as the Senegal. My specimen, from the latter river, is heavier and more inflated than those which I have from the Nile. Deshayes places it in the genus *Iridina*, asserting that the animal differs from the *Anodonta*, and is similar to that of the *Iridina*.

Anodonta crispata. This is a distinct and beautiful species, peculiar for its transverse furrows. I owe to the kindness of Baron de Ferussac the possession of this rare shell, the habitat of which is Cayenne. Lamarck says, "dans les rivières des regions australes?"

Anodonta uniopsis is a distinct species, and probably from New Holland.

Anodonta Pennsylvanica. I examined the specimen described by Lamarck. It is in the cabinet of the Duke de Rivoli, and is the same with the *undulata* of Say, *rugosus* of Swainson.

Anodonta intermedia is a variety of *anatina*. The *intermedia* of Pfeiffer is a variety of *cygnea*.

Anodonta trapezialis. The specimen described by Lamarck is in the Garden of Plants. It is the *giganteus* of Spix, who figures it in his beautiful work. Its habitat is Brazil. Lamarck says, "des eaux douces étrangères à celles de l'Europe?" It is less transverse, and has more volume than the following, which it closely resembles.

Anodonta exotica. I examined specimens of this species in the cabinets of the Duke de Rivoli, Baron de Ferussac and the Garden of Plants. Lamarck's habitat says, "les rivières de l'Inde?" I believe it comes only from the more southern rivers of South America. My specimens, and those I saw in Europe, came from the river La Plata. It has a peculiar character, which Lamarck does not notice, in the deposit of epidermal matter at different stages of growth, with the nacre extending in waved lines, generally from one great cicatrix to the other, forming curves parallel with the palleal cicatrix.

Anodonta glauca is a distinct species, inhabiting Mexico, and figured in a recent number of Humboldt's great work.

Anodonta sinuosa. I saw the specimen described, in Baron de Ferussac's cabinet. It is very distinct, and very peculiar in the sinuous dorsal line. This species is in my cabinet.

Anodonta Patagonica. This is also a distinct and very rare species. The possession of a specimen I owe to the kindness of Mr G. B. Sowerby.

Iridina exotica. To Baron de Ferussac I owe the possession of this species. It appears to differ from the *Nilotica* in being *tuberculated* along the dorsal line, which is one of Lamarck's generic characters. The *Nilotica*, which I received from the African traveller Monsieur Cailliaud, has no crenulations along the dorsal line, but I have seen specimens on which a few could be observed. The *Clappertoni* of Denman is a young *Nilotica.*

SECOND SUPPLEMENT.

Read before the American Philosophical Society, February 7th, 1834.

Unio Shepardianus. Plate XIII. fig. 38.

Testâ sublanceolatâ, transversissimâ, valde inæquilaterali, antice rotundatâ, postice obtuso-angulatâ, inferne emarginatâ, ad latera planulatâ ; clivo umboniali elevato ; valvulis subcrassis ; natibus parvis, prope marginem anteriorem positis ; epidermide tenebroso-fuscâ, obsolete radiatâ ; dente cardinali obliquo, in valvulâ dextrâ unico, in sinistrâ duplici ; dente laterali longissimo rectoque ; margaritâ purpureâ et iridescente.

Shell sublanceolate, very transverse, very inequilateral, rounded before, obtusely angular behind, emarginate at base, flattened on the sides ; umbonial slope elevated ; valves somewhat thick ; beaks small and placed near the anterior margin ; epidermis dark brown with obsolete rays ; cardinal teeth oblique, single in the right and double in the left valve ; lateral teeth very long and straight ; nacre purple and iridescent.

Hab. Hopeton, near Darien, Georgia. Professor Shepard.
My Cabinet.
Cabinet of Professor Shepard.

Diam. 1, Length 1·4, Breadth 5 inches.

Shell sublanceolate, very transverse, very inequilateral, rounded before, obtusely angular behind, emarginate at base, flattened over the umbones and sides; umbonial slope forming an oblique ridge; substance of the shell rather thick; beaks small and placed near to the anterior margin; ligament thin and long; epidermis dark brown, almost black, with obsolete rays on the more perfect individuals; cardinal teeth erect, single in the right valve and double in the left; lateral teeth very long and straight; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices in the centre of the cavity of the beaks: cavity of the beaks very shallow; cavity of the shell deep under the umbonial slope; nacre beautifully purple and iridescent.

Remarks.—This remarkable species, in its great transverseness and outline, has some resemblance to *U. Grayanus* (nobis). It is much more transverse than any species heretofore discovered from this country. The purple of the interior is like that of the *complanatus* (Soland.). In one specimen there is a muscular impression near the centre of the cavity of the shell, similar to that of the *U. trapezoides* (nobis). In another specimen there are obsolete marks of an impression. The third has none that can be distinguished.

I am indebted to the great kindness of professor Shepard of New Haven for this interesting and curious species, and it is with pleasure I dedicate it to him.

Unio fulvus. Plate XIII. fig. 39.

Testâ angusto-ellipticâ, inæquilaterali, transversâ, posticè subangulatâ; clivo umboniali rotundato; valvulis tenuiculis; natibus prominulis; epidermide luteâ; dente cardinali obliquo, laterali subcurvo; margaritâ salmonis colore tinctâ.

Shell narrow-elliptical, inequilateral, transverse, subangular behind; umbonial slope rounded; valves rather thin; beaks slightly elevated; epidermis yellow; cardinal teeth oblique; lateral teeth somewhat curved; nacre salmon.

Hab. . . . . , South Carolina. Dr Blanding.
My Cabinet.
Cabinet of Dr Blanding.

Diam. ·6, Length ·9, Breadth 1·6 inches.

Shell narrow-elliptical, inequilateral, transverse, slightly inflated; umbonial slope rounded; substance of the shell rather thin; beaks slightly elevated, placed towards the anterior margin; ligament thin and rather short; epidermis yellow and yellowish brown; cardinal teeth oblique, short, disposed to be lobed, single in the right and double in the left valve; lateral teeth slightly curved, rather long; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices placed in the centre of the cavity of the beaks; cavity of the beaks very shallow; cavity of the shell somewhat deep; nacre salmon.

Remarks.—This species has, perhaps, most resemblance in its exterior to the *marginalis* (Lamarck), which comes from the great rivers of India. In the interior, however, it differs much. Our shell is of a very dark salmon colour. It is also a thicker shell, and the teeth are much thicker. In the colour of the epidermis it somewhat resembles the *lanceolatus* (nobis).

UNIO MODIOLIFORMIS. Plate XIII. fig. 40.

Testâ ovatâ, transversâ, inæquilaterali, inflatâ, antice angustâ, postice latâ; valvulis tenuissimis; natibus minutis et fere terminalibus; dentibus cardinalibus parvis, compressis, lateralibus longis curvisque; margaritâ subpurpureâ, valde iridescenti.

Shell ovate, transverse, very inequilateral, inflated, narrow before and broad behind; valves very thin; beaks small, nearly terminal; cardinal teeth small, compressed; lateral teeth long and curved; nacre slightly purple, very iridescent.

Hab. Santee Canal, South Carolina. Professor Ravenel.
My Cabinet.
Cabinet of Professor Ravenel.
Cabinet of P. H. Nicklin.

Diam. 1·1, Length 1·5, Breadth 2·7 inches.

Shell reversely ovate, transverse, very inequilateral, inflated, narrow before and broad behind, emarginate at basal margin; substance of the shell very thin, diaphanous; beaks small, nearly terminal, slightly undulated; ligament rather long and thin; epidermis brown, shining; rays indistinct; cardinal teeth small, compressed, disposed to be double in the left and single in the right valve; lateral teeth long, curved and elevated in their direction; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices small, situated in the cavity of the beaks; cavity of the shell deep; cavity of the beaks shallow; nacre slightly purple, very iridescent.

Remarks.—The spreading out of the posterior portion of the shell, and the narrowness of the anterior portion, is very striking in this species. I know of no other species which has its lateral teeth so much elevated, following, as they do, the widened margin of the valve. The cardinal teeth are generally double in the left valve, but not always. They will always be found to be compressed in both valves, and generally more elevated in the right. The nacre is so very thin as to be diaphanous, and the play of iridescent colours is very beautiful. As the individual advances in age the marks of growth form large wrinkles, and it then becomes more cylindrical.

Unio Kirtlandianus. Plate XIV. fig. 41.

Testâ subrotundâ, compressâ ; valvulis crassis ; natibus subprominentibus ; epidermide circa nates luteâ, juxta marginem fuscâ ; radiis interruptis ; dentibus cardinalibus subcrassis, lateralibus subcurvis brevibusque ; margaritâ albâ et iridescente.

Shell rather round, compressed ; valves thick ; beaks somewhat elevated ; epidermis yellowish about the beaks, brown towards the margin ; rays interrupted ; cardinal teeth rather thick ; lateral teeth short and slightly curved ; nacre pearly white and iridescent.

Hab. Mahoning, Ohio. J. P. Kirtland, M.D.
My Cabinet.
Cabinet of P. H. Nicklin.

Diam. 1, Length 2, Breadth 2·3 inches.

Shell rather round, compressed; substance of the shell thick, somewhat thinner behind; beaks rather elevated; ligament rather short and thick; epidermis wrinkled, dark brown, smooth and yellowish in the region of the beaks; interrupted rays pass from the beaks and are very visible over the umbones, but are lost in the wrinkles before they reach the margin; cardinal teeth rather thick; lateral teeth short, thick and slightly curved; posterior and anterior cicatrices both distinct; dorsal cicatrices situated on the under side of the cardinal teeth; cavity of the shell flat and shallow; cavity of the beaks rather deep and angulated; nacre pearly white and iridescent.

Remarks.—I owe this new species to the kindness of Dr Kirtland of

Poland, Ohio. It is very nearly allied to the *subrotundus* (nobis), and when I first received a few specimens, I doubted if it was more than a variety of that species. Subsequently receiving from the same naturalist more and better specimens, I was satisfied that it was specifically different. Specimens of the true *subrotundus* having accompanied these, it could not be, of course, a variety occasioned, as is sometimes the case, by mere locality. It differs from the *subrotundus* in being much flatter, in having smaller beaks, and in being of a darker brown—the beaks are less yellow—the rays, interrupted like that shell, tend generally nearer to the margin. In older specimens than the one figured, the posterior part becomes protruded, which gives an obliqueness to the shell.

Unio Paranensis. Plate XIV. fig. 42.

Testâ subrotundatâ, inæquilaterali, compressâ; valvulis subcrassis; natibus plicatis retusis; dentibus cardinalibus recurvis, in valvulâ utrâque duplicibus; lateralibus sublongis curvisque; margaritâ albâ et iridescente.

Shell subrotund, inequilateral, compressed; valves somewhat thick; beaks folded, retuse; cardinal teeth recurved, double in both valves; lateral teeth rather long and curved; nacre pearly white and iridescent.

Hab. River Parana. Dr Burrough.

Cabinet of Dr Burrough.

Diam. 1·3, Length 3, Breadth 3·5 inches.

Shell subrotund, disposed to be pentagonal, inequilateral, compressed towards the margin, emarginate on the posterior dorsal margin; umbonial slope flattened; substance of the shell somewhat thick; beaks rather elevated, longitudinally folded, retuse; ligament rather long and thin; epidermis wrinkled, shining, greenish on the beaks and brown towards the margin, furnished with very obscure curved rays, which sweep from the beak towards the anterior part; cardinal teeth recurved, compressed, double in both valves; lateral teeth lamellar, rather long and curved; anterior cicatrices confluent; posterior cicatrices confluent;

dorsal cicatrices in the centre of the cavity of the beaks; palleal impression small and distant from the margin; cavity of the shell very shallow; cavity of the beaks small, subangular; nacre pearly white and iridescent.

Remarks.—I am indebted to the kindness of Dr Burrough for the advantage of examining and describing this interesting species. It was procured by him, during his late voyage round the world, at Buenos Ayres, having been brought from the river Parana. It is remarkable for its outline, its expanded basal margin and folded beaks.

Unio Nashvillianus. Plate XIV. fig. 43.

Testâ ellipticâ, transversâ, inæquilaterali; valvulis subcrassis; natibus prominulis et minute undulatis; dentibus cardinalibus laminatis et in valvulâ utrâque duplicibus, lateralibus subrectis; margaritâ albâ.

Shell elliptical, transverse, inequilateral; valves somewhat thick; beaks slightly elevated and minutely undulated; cardinal teeth lamelliform and double in both valves; lateral teeth nearly straight; nacre pearly white.

Hab. Cumberland River. Professor Troost.
Ohio, at Louisville. Dr Fitch.
My Cabinet.
Cabinet of Professor Troost.

Diam. ·9, Length 1·4, Breadth 2·5 inches.

Shell elliptical, sometimes truncate behind, transverse, inequilateral; substance of the shell somewhat thick; beaks slightly elevated and minutely undulated at the tip; ligament rather short and straight; epidermis dark brown, obscurely rayed; cardinal teeth lamelliform, disposed to be crenulate, double in both valves; lateral teeth nearly straight, the inferior section in the left valve being enlarged towards the posterior end; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices in the centre of the cavity of the beaks; cavity of the beaks angular, rather shallow; nacre beautifully pearly white, disposed in many individuals to be pinkish on the posterior part of the shell.

Remarks.—This species has most resemblance in its general characters to the *parvus* (Barnes). It is, however, a larger shell, and in the undulations of the beaks it is very different. Like the *parvus*, the *siliquoideus*, the *cariosus* and *crassus*, it is sometimes very much truncated behind. In this state it might be mistaken for a different species, did not, as in the abovementioned species, the other characters strictly identify it.

UNIO BLANDINGIANUS. Plate XV. fig. 44.

Testâ subtrapezoideâ, transversâ, inæquilaterali, subinflatâ; valvulis tenuibus; natibus prominulis; dentibus cardinalibus compressis; lateralibus longis curvisque; margaritâ purpureâ.

Shell subtrapezoidal, transverse, inequilateral, somewhat inflated; valves thin; beaks somewhat prominent; cardinal teeth compressed; lateral teeth long and curved; nacre purple.

Hab. St John's river, ? Florida. Dr Blanding.
My Cabinet.
Cabinet of Dr Blanding.

Diam. ·9, Length 1·5, Breadth 2·3 inches.

Shell subtrapezoidal, transverse, very inequilateral, somewhat inflated; substance of the shell thin; beaks somewhat prominent, placed near to the anterior margin; ligament rather long and narrow; epidermis fuscous, wrinkled; cardinal teeth compressed, double in the left valve and single in the right; lateral teeth long, curved and somewhat lamellar; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices placed in the centre of the cavity of the beaks; cavity of the shell rather deep; cavity of the beaks wide and shallow; nacre dull purple.

Remarks.—I owe to the kindness of Dr Blanding the specimens of this species which are in my cabinet. They were procured by this naturalist while in St Augustine, from an Indian whom he had directed to collect for him, and it is presumed they came from St John's river or some of its tributaries. This species has somewhat the characters of the *obesus* (nobis), and the *complanatus* (Solander). It is not so much inflated as the former, and is more so than the latter. My oldest specimen is subemarginate on the basal margin. In all those procured by Dr Blanding, the beaks were much eroded.

Unio camelus. Plate XV. fig. 45.

Testâ subtriangulari, inæquilaterali, complanatâ per umbones a natibus usque ad marginem inferiorem; valvulis crassis; radiis sparsis capillaribusque; dente cardinali parvo, laterali magno, crasso, curvato; margaritâ albâ.

Shell subtriangular, inequilateral, flattened over the umbones from the beaks to the basal margin; valves thick; rays scattered and capillary; cardinal teeth small; lateral teeth large, thick and curved; nacre white.

Hab. Ohio river. T. G. Lea.

My Cabinet.

Diam. 1·4, Length 2·3, Breadth 3·4 inches.

Shell subtriangular, inequilateral, angular behind, flattened over the umbones from the beaks to the basal margin; substance of the shell thick; ligament thick; epidermis yellow brown, with capillary rays; cardinal teeth small; lateral teeth very large, thick and curved; anterior and posterior cicatrices both distinct; dorsal cicatrices situated on the inferior part of the cardinal teeth; cavity of the shell shallow, welted; cavity of the beaks very shallow.

Remarks.—This species seems to possess partly the characters of the *gibbosus* (Barnes), and partly those of the *planulatus* (nobis). It may be distinguished from them by its high dorsal margin, its very remarkably thick lateral tooth and its capillary rays.

Unio Griffithianus. Plate XV. fig. 46.

Testâ ellipticâ, expansâ, transversâ, inæquilaterali, lateribus subplanulatis; clivo umboniali rotundato; valvulis subcrassis; natibus parvis; epidermide luteolâ viridi-radiatâ; dente cardinali parvo et lobis instructo; laterali longo, curvo et ad terminum posteriorem aucto; margaritâ purpureâ, albâ, vel salmonis colore tinctâ.

Shell elliptical, spread out, transverse, inequilateral, somewhat flattened on the sides; umbonial slope rounded; valves somewhat thick; beaks small; epidermis yellowish, with green rays; cardinal teeth small, lobed; lateral teeth long, curved and enlarged at posterior end; nacre purple, salmon or white.

Hab. South Carolina. Professor Ravenel.
My Cabinet.
Cabinet of Professor Ravenel, Charleston, South Carolina.
Diam. ·6, Length 1·2, Breadth 2·2 inches.

Shell elliptical, spread out, transverse, inequilateral; somewhat flattened on the sides, rounded on the umbonial slope; substance of the shell somewhat thick; beaks small, scarcely elevated; ligament somewhat long and narrow; epidermis yellowish, with green diverging rays; cardinal teeth small, lobed, disposed to be double in both valves; lateral teeth long, curved and enlarged at the posterior end; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices situated across the cavity of the beaks; cavity of the beaks rather shallow; cavity of the shell shallow; nacre purple, salmon or white.

Remarks.—Although this shell is very like the *complanatus* (Soland.), I have thought it sufficiently distinct to separate it. It is more rounded before, and more spread out, forming a more perfect ellipsis. In the nacre it is very much the same. I name it after my friend R. E. Griffith, M.D.

Unio confertus. Plate XVI. fig. 47.

Testâ trapezoideâ, transversâ, inæquilaterali, inflatâ; valvulis subcrassis; natibus prominulis et transversim rugatis; dentibus cardinalibus compressis, et in *valvulâ utrâque duplicibus; lateralibus longis curvisque; margaritâ purpureâ, aut salmonis colore tinctâ.*

Shell trapezoidal, transverse, inequilateral, inflated; valves rather thick; beaks slightly elevated and transversely wrinkled; cardinal teeth compressed and double in both valves; lateral teeth long and curved; nacre purple or salmon.

Hab. Santee Canal, South Carolina. Professor Ravenel.
My Cabinet.
Cabinet of Professor Ravenel.

Diam. 1·1, Length 1·3, Breadth 2·4 inches.

Shell trapezoidal, transverse, inequilateral, inflated; substance of the shell rather thick; beaks slightly elevated, incurved, transversely wrinkled; umbones very much swollen; ligament rather short and thin; epidermis dark brown, shining; cardinal teeth very much compressed; lateral teeth long and slightly curved; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices on the superior part of the cavity of the beaks; cavity of the shell very deep; cavity of the beaks full and rounded; nacre purple or salmon.

Remarks.—The *confertus*, in its general characters, resembles the *complanatus* (Solander). It is, however, much more inflated, and differs in having teeth more compressed. The specimens in my cabinet I owe to the kindness of professor Ravenel. These are all without rays. In young specimens they may exist.

Symphynota Benedictensis. Plate XVI. fig. 48.

Testâ trapezio simili, inæquilaterâ, transversâ, subcompressâ, margine dorsali subrectâ; valvulis pertenuibus; natibus subprominentibus, apicibus granulatis; cicatricibus vix cernendis; margaritâ cœruleo-albâ et iridescente.

Shell trapezoidal, inequilateral, transverse, rather compressed, nearly straight on the dorsal margin; valves very thin; beaks somewhat prominent, and granulate at tip; cicatrices scarcely perceptible; nacre bluish white and iridescent.

Hab. Lake Champlain.

My Cabinet.

Cabinet of Professor Benedict, Burlington, Vermont.

Diam. 1·4, Length 2·2, Breadth 3·6 inches.

Shell trapezoidal, inequilateral, transverse, rather compressed, nearly straight on the dorsal margin; substance of the shell very thin; epidermis shining, yellowish olive, with rather strong lines of growth; beaks somewhat prominent and granulate at tip; cicatrices scarcely perceptible; cavity of the beaks shallow; cavity of the disk rather shallow; nacre bluish white and iridescent.

Remarks.—On my way to Quebec, in the summer of 1829, I spent a few minutes on the shore of lake Champlain, nearly opposite to fort Ticonderoga, waiting for the steamboat. These minutes were improved in the search of the shells near the edge of the water. Among others hastily seized, was a single individual of the present species, which, though an alive specimen, was much decorticated. Unwilling to describe it as a new species, without better individuals for examination, I have endeavoured in vain to procure them until the present time. I owe to the kindness of professor Benedict a suite of different ages which verify my previous impression, and to him I dedicate the species. In outline (except the wings) it resembles the *Symphynota bi-alata* (nobis). It is not, however, so large or so thick a shell, and has neither tooth nor undulations.

Anodonta Burroughiana. Plate XVI. fig. 49.

Testâ ovatâ, valde inæquilaterali, subinflatâ; valvulis tenuibus; natibus prominulis; lineâ dorsali curvâ; margaritâ purpureâ.

Shell ovate, very inequilateral, slightly inflated; valves thin; beaks slightly elevated; dorsal line curved; nacre purple.

Hab. Island of Luconia, near Manilla. Dr Burrough.

My Cabinet.

Cabinet of Dr Burrough.

Diam. ·8, Length 1·3, Breadth 2·1 inches.

Shell reversely ovate, very inequilateral, slightly inflated, rather straight on the basal margin and elevated on the posterior dorsal margin; substance of the shell thin; beaks slightly elevated; ligament long and narrow; epidermis dark brown and rather smooth; anterior and posterior cicatrices confluent; dorsal cicatrices situated in the cavity of the beaks; cavity of the shell wide and rather deep; cavity of the beaks very shallow; nacre purple.

Remarks.—To the kindness of Dr Burrough I am indebted for the privilege of describing this species. It is with pleasure I take the opportunity of placing his name upon it. It was procured by him near the city of Manilla. It resembles, in outline and colour, the *Unio cuprinus* (nobis), but has no trace of teeth. It is most remarkable perhaps for its deep colour.

MARGARITANA* RAVENELIANA. Plate XVII. fig. 50.

Testâ subcylindraceâ, valde transversâ et inæquilaterali, inflatâ; valvulis tenuibus; natibus exiguis; dentibus cardinalibus parvis, subcompressis; margaritâ cœruleo-albâ.

Shell subcylindrical, very transverse, inequilateral, inflated; valves thin; beaks small; cardinal teeth small, rather compressed; nacre bluish white.

Hab. French Broad and Swananoe rivers, North Carolina.

My Cabinet.

Cabinet of Dr Ravenel.

Diam. ·9, Length 1·1, Breadth 2·2 inches.

Shell subcylindrical, very transverse, inequilateral, inflated, disposed to be compressed near the basal margin, where it is often emarginate; substance of the shell thin; beaks small; ligament rather short; epidermis brown, with rays on the posterior part; umbonial slope large, rounded; cardinal teeth consisting in each valve of a small compressed

* See note at page 429, Vol. III.

lobe; anterior cicatrices confluent; posterior cicatrices confluent; dorsal cicatrices placed under the cardinal teeth; cavity of the shell deep; cavity of the beaks shallow; nacre bluish white.

Remarks.—This species most resembles the *Alasmodonta marginata* (Say), but may be distinguished by its more cylindrical form, and its want of undulations on the posterior slope. It differs also in the roundness of the umbonial slope, and in the rays. In the *marginata* the rays are more interrupted and scattered, being sometimes quite spotted.

Cyrena rotundata. Plate XVII. fig. 51.

Testâ rotundatâ, sublenticulari, subæquilaterali, transversim rugatâ; clivo posteriori rugoso; valvulis crassis; natibus parvis, acutis, contiguis; dentibus cardinalibus subbifidis, lateralibus longis, minute serratis, rectisque; margaritâ albâ et purpureâ.

Shell round, sublenticular, nearly equilateral, transversely wrinkled, rugose on the posterior slope; valves thick; beaks small, pointed, touching; cardinal teeth disposed to be bifid; lateral teeth long, straight and minutely serrulate; nacre white and pinkish.

Hab. . . . .

My Cabinet.

Diam. 1·5, Length 2·9, Breadth 3·3 inches.

Shell round, sublenticular, nearly equilateral, transversely and rather minutely wrinkled, rugose on the posterior slope; substance of the shell thick; beaks small, pointed, touching; ligament very short and thick; epidermis yellowish brown before and dark brown behind; anterior slope furnished with a lanceolate mark formed by two curved yellow lines, which pass from the beaks to the anterior margin; posterior slope rugose, furnished with obsolete oblique folds; cardinal teeth disposed to be bifid; lateral teeth long, straight and very minutely serrulate; cicatrices scarcely perceptible; cavity of the shell rather shallow; cavity of the beaks subangular; nacre white and pinkish.

Remarks.—This beautiful and fine large species was sent to me some years since by a dealer in Paris. It perhaps most resembles the *Zeylanica* (Lamarck). It differs, however, in being more compressed, more rotund, in having longer lateral teeth, and in these being serrulate. The nacre is rather thinner, and is coloured. On comparison it will be observed that the anterior tooth of the *Zeylanica* is merely a tubercle, while that of *rotundata* is long and lamellar. The nacre is disposed to be pinkish on the posterior part.

Cyrena Jayensis. Plate XVII. fig. 52.

Testâ subrotundâ, subæquilaterali, antice rugosâ; valvulis crassis; natibus parvis, elevatis; dentibus cardinalibus bifidis, lateralibus longis, minute serratis, rectisque; margaritâ purpureâ.

Shell subrotund, nearly equilateral, transversely wrinkled on the anterior part; valves rather thick; beaks small, elevated; cardinal teeth bifid; lateral teeth long, nearly straight, and minutely serrulate; nacre purple.

Hab. Batavia? J. C. Jay, M.D.
My Cabinet.
Cabinet of Dr Jay.

Diam. 1·1, Length 2·2, Breadth 2·3 inches.

Shell subrotund, nearly equilateral, furnished with transverse rather large wrinkles on the anterior part; substance of the shell rather thick; beaks small, elevated, retuse; ligament very short and thick; epidermis dark brown, shining; cardinal teeth bifid, long, nearly straight and minutely serrulate; cicatrices scarcely perceptible; cavity of the shell shallow; cavity of the beaks subangular; nacre dark purple, sometimes whitish.

Remarks.—It is to the kindness of Dr Jay I am indebted for the specimen figured. That of his cabinet is rather more oblique than this. The *Jayensis* has some resemblance to the *rotundata*, described herein, but differs in having rather large wrinkles on the anterior part, in having more elevated beaks, and in the dark purple colour of the nacre.

Cyrena turgida. Plate XVIII. fig. 53.

Testâ trigonâ, inflatâ, parte anticâ turgidâ, rugosâ, inæquilaterâ, transversim rugatâ; valvulis crassis; natibus elevatis, recurvis; dentibus cardinalibus sub-bifidis, dente anteriore laterali brevi et elevato, posteriore longo et laminato; margaritâ albâ.

Shell triangular, inflated, swollen on the anterior part, rugose, inequilateral, transversely wrinkled; valves thick; beaks elevated, recurved; cardinal teeth disposed to be bifid; anterior lateral tooth short and elevated; posterior lateral tooth long and lamellar; nacre white.

Hab. . . . . , India. Rev. William Carey.
My Cabinet.

Diam. 1·2, Length 1·7, Breadth 2·1 inches.

Shell triangular, inflated, swollen on the anterior part, rugose, inequilateral, transversely wrinkled; substance of the shell thick; beaks elevated, recurved; ligament rather long and narrow; epidermis yellowish brown, darker towards the margin; cardinal teeth disposed to be bifid; anterior lateral tooth short and elevated, somewhat conical; posterior lateral tooth long and lamellar; cicatrices scarcely perceptible; cavity of the shell deep and rounded; cavity of the beaks angular; nacre white.

Remarks.—To the kindness of Dr Carey of Calcutta I owe several specimens of this species. In the teeth it resembles the *C. Zeylanica* (Lamarck), and the *C. papua* (Lesson). It differs from both in being more triangular, more inflated, as well as in being a smaller species. In the enlargement of the anterior part, which seems to be turgid or swollen, it differs from any *Cyrena* with which I am acquainted. Being without serrulate teeth, it belongs to Lamarck's second division—" dents latérales entières.

Cyrena Woodiana. Plate XVIII. fig. 55.

Testâ subtrigonâ, subinflatâ, micante, subæquilaterali, transversim rugatâ; valvulis crassis; natibus magnis et rotundatis; dentibus cardinalibus sub-bifidis, lateralibus longis, serratis, rectisque; margaritâ albâ.

Shell subtriangular, somewhat inflated, shining, nearly equilateral, transversely wrinkled; valves thick; beaks large and rounded; cardinal teeth disposed to be bifid; lateral teeth long, straight, serrulate; nacre white.

Hab. Canton. W. W. Wood.
My Cabinet.

Diam. 1·4, Length 2·4, Breadth 2·9 inches.

Shell subtriangular, obtusely angular behind, somewhat inflated, shining, nearly equilateral, transversely and rather largely wrinkled; substance of the shell thick; beaks large, rounded, not very approximate; ligament rather short and thick; epidermis blackish brown, polished, except on posterior slope; wrinkles larger near to the margin; cardinal teeth disposed to be bifid; lateral teeth long, straight, serrulate; cicatrices scarcely perceptible; cavity of the shell deep; cavity of the beaks angular; nacre white.

Remarks.—In the intenseness of colour of the epidermis, and its high polish, this species differs from any I am acquainted with. It is more inflated and less rotund than the *rotundata* herein described. Its lateral teeth are longer and not so minutely serrulate. In its triangular form it resembles the *C. papua* (Lesson). The nacre has not the clear white usual in this genus. In this specimen, below the palleal impression, it is yellowish white.

Mr Wood, to whose great kindness I owe this fine and interesting species, informed me he procured it from a boat on the river below Canton, it having been fished up by accident, when the fishermen were engaged in catching other shell fish. Owing the possession of it to him, I with great pleasure dedicate it to him.

GENUS APHRODITE (nobis).

Testâ æquivalvi, subtrigonâ, inæquilaterali; dente cardinali subnullo; dentibus lateralibus binis, sublongis; ligamento externo.

Shell equivalve, subtriangular, inequilateral; hinge with a very imperfect or no cardinal tooth; lateral teeth two, rather long; ligament external.

Remarks.—The genus *Aphrodite* is proposed for a single species which I am unable to place with any established genus. I suspect it to be an estuary shell, and should it prove so, its proper place will be after the genus *Cyrena.* The lateral teeth are placed somewhat like those in that genus, but the epidermis and substance of the shell differ entirely, being more like the genus *Mactra.*

A. columba. Plate XVIII. fig. 54.

Testâ subcompressâ, longitudinaliter et obsolete striatâ, transversim et minute rugatâ, colore columbæ tinctâ, super umbones subrufis maculis ungulatis munitâ; valvulis tenuibus; natibus elevatis, acutis; dentibus cardinalibus obsoletis, lateralibus binis; margaritâ luteo-albâ.

Shell rather compressed, longitudinally and obsoletely striate, transversely and minutely wrinkled, dove coloured, on the umbones furnished with reddish angular marks; valves thin; beaks elevated, pointed; cardinal teeth obsolete; lateral teeth two; nacre yellowish white.

Hab. . . . .

My Cabinet.

Diam. 1·4, Length 2·9, Breadth 3·4 inches.

Shell subtriangular, nearly equilateral, rather compressed, longitudinally and obsoletely striate, transversely and minutely wrinkled, dove coloured, furnished on the umbones with reddish angular marks; substance of the shell thin and fragile; beaks elevated, pointed, touching; ligament short and thick; epidermis thin; cardinal teeth obsolete or wanting; lateral teeth two, rather long, straight, and disposed to be lamellar; cicatrices smooth, impressed, showing the mark of their advancement; palleal impression indistinct, broad; cavity of the shell rather shallow; cavity of the beaks angular; nacre yellowish white and shining.

Remarks.—This is certainly a very interesting shell. It is difficult to find any one to compare it with. On the inside of the anterior margin there appears to be a disposition to crenulation, caused by the longitudinal striæ. Its habitat I am not acquainted with, having purchased my specimens at a dealer's in Europe, who could not inform me from what country they came.

Io spinosa. Plate XIX. fig. 79.

Testâ obtuse turritâ, latâ, corneâ, sub epidermide fasciatâ, spinis magnis; anfractibus septenis; aperturâ elongatâ, dimidium longitudinis testæ habente.

Shell obtusely turrited, wide, horn colour, under the epidermis banded, furnished with large spines; whorls seven; mouth elongate, one half the length of the shell.

Hab. Holston River, Washington County, Virginia. Professor Troost.

My Cabinet.
Cabinet of Professor Troost.

Diam. 1·2, Length 2·2 inches.

Remarks.—This species resembles very much the *Io fusiformis* (nobis), *Fusus fluviatilis* (Say), but may be distinguished by its large transversely compressed spines, the *fusiformis* having somewhat longitudinal tubercles. I am not acquainted with any fluviatile shell which has such large spines (there being about seven on each whorl), nor any which has such a general resemblance to a marine shell. Professor Troost informs me they are rare in the river, that they had been observed in the graves of the aborigines; and as it was generally believed that these were "conch shells," consequently coming from the sea, it was urged that the inhabitants who possessed them must have come over the sea. It does not appear that they had been observed in their native element, though living at the very doors of the persons who had remarked them in the tumuli.

PALUDINA BURROUGHIANA. Plate XIX. fig. 80.

Testâ turritâ, tenebroso-corneâ, transversim striatâ, striis majoribus duabus vel tribus circiter medium anfractum; suturis profundis; anfractibus senis, valde convexis; aperturâ rotundatâ, albâ.

Shell turrited, dark horn colour, transversely striated, having two or three large striæ about the middle of the whorl; sutures very deep; whorls six, very convex; mouth round, white.

Hab. Island of Luconia. Dr Burrough.
My Cabinet.
Cabinet of Dr Burrough.
Cabinet of the Academy of Natural Sciences of Philadelphia.
Diam. 1·2, Length 1·8 inches.
Operculum thin, light brown.

Remarks.—This is perhaps the largest species of *Paludina* which has yet been observed. It is remarkable for the numerous fine transverse striæ which are subgranose or undulated, and which cover, in some specimens, the whole of the whorls. About the middle of the whorls there are several larger striæ, the largest being always, in the specimens examined by me, immediately above the suture. I owe to Dr Burrough's great kindness the opportunity of describing this species. During his late voyage he procured it, with many other fine shells, from the vicinity of Manilla, in the island of Luconia.

Read before the American Philosophical Society, April 18th, 1834.

LYMNÆA ACUTA. Plate XIX. fig. 81.

Testâ elongato-turritâ, tenui, lævi, fusco-nigricante; spirâ attenuatâ; anfractibus senis; aperturâ subovatâ.

Shell elevated, turrited, thin, smooth, dark brown; spire attenuate; whorls six; aperture subovate.

Hab. pond four miles north of Philadelphia.
Diam. ·3, Length ·7 of an inch.

Remarks.—This delicate species, although attenuate, is not so much so as the *exilis* herein described. Its whorls are more convex and the body whorl larger, the aperture being about one half the length of the shell. Several specimens were found by me some years since, in a very small pond near to the Falls of Schuylkill. Since then this pond has occasionally dried up, and I have not been able to find others. Although there are other ponds near to this, which other species inhabit, I have never been able to discover the *acuta* in any other spot.

LYMNÆA EXILIS. Plate XIX. fig. 82.

Testâ attenuatâ, tenuissimâ, longitudinaliter striatâ; anfractibus septenis, plano-convexis; columellâ reflexâ; aperturâ ovato-oblongâ.

Shell attenuated, very thin, longitudinally striate; whorls seven, plano-convex; columella reflected; aperture ovato-oblong.

Hab. Ohio, T. G. Lea.
My Cabinet.
Diam. ·4, Length 1·5 inches.

Remarks.—This is perhaps the most attenuated Lymnæa yet observed in this country. It approaches most to the *reflexus* (Say), but is more elongate than that species. The most remarkable character of the *exilis* is, perhaps, the reflection of its labium, which is not laid on the body of the whorl. Where it joins above with the labrum, the angle is quite acute, and is separated from the body whorl. The specimen figured was not taken alive, and the epidermis being destroyed, the description and representation are partially defective. The aperture is about two-fifths the length of the shell.

PHYSA ELLIPTICA. Plate XIX. fig. 83.

Testâ sinistrosâ, ellipticâ, tenuissimâ, pellucidâ, castaneâ, nitidâ; spirâ breviusculâ; anfractibus quaternis; labro marginato; aperturâ angustatâ.

Shell sinister, elliptical, very thin, pellucid, chesnut coloured, shining; spire rather short; whorls four; outer lip margined; aperture narrow.

Hab. . . . . T. G. Lea.

My Cabinet.

Diam. ·2, Length ·5 of an inch

Remarks.—This species is less inflated and more of a chestnut colour than any I am acquainted with. Its colour is almost reddish, and the light coloured margin of the outer lip is remarkable. The aperture is rather contracted, and the whole shell somewhat elongate.

AMPULLARIA HOPETONENSIS. Plate XIX. fig. 84.

Testâ subventricosâ, lævi, superne subplanulatâ, perforatâ, luteo-fuscescente, fasciatâ; suturis impressis; anfractibus quinis; aperturâ subovatâ, albâ.

Shell subventricose, smooth, flattened above, umbilicate, yellowish-brown, banded; sutures impressed; whorls five; aperture subovate, white.

Hab. Hopeton, near Darien, Georgia. Professor Shepard.
My Cabinet.
Cabinet of Professor Shepard.

Diam. 1·4, Length 1·7 inches.

Remarks.—I owe to the kindness of professor Shepard of New Haven this interesting shell. It was procured by him during his late geological investigations in our southern states, with other shells, descriptions of which will be found in these memoirs. It resembles the *A. fasciata* (Lam.), but is less globose, the whorls of our species being somewhat flattened on the side and top. It differs from the *A. depressa* (Say), described in major Long's expedition to St Peter's river (subsequently changed to *A. paludosa* in the Disseminator), in being less globose, and in being flatter on the side and superior part of the whorls.

Paludina Georgiana. Plate XIX. fig. 85.

Testâ ventricoso-conoideâ, tenui, tenebroso-corneâ, lævi; suturis valde impressis; anfractibus instar quinis, convexis; aperturâ subrotundatâ, albâ.

Shell ventricoso-conical, thin, dark horn coloured, smooth; sutures very much impressed; whorls about five, convex; aperture nearly round, white.

Hab. Hopeton, near Darien, Georgia. Professor Shepard.
My Cabinet.
Cabinet of Professor Shepard.

Diam. ·7, Length 1·1 inches.

Remarks.—This species, in form, resembles most, perhaps, the *P. vivipara.* It is not quite so large, nor has it bands. It is rather more elevated, and the body whorl is smaller and rounder than the *P. decisa* (Say). The aperture at the base recedes more than is usual with this genus.

SUCCINEA RETUSA. Plate XIX. fig. 86.

Testâ ovato-oblongâ, tenuissimâ, pellucidâ, flavidulâ ; spirâ brevi ; anfractibus ternis ; aperturâ inferne dilatatâ et retractâ.

Shell ovately oblong, very thin, pellucid, yellowish ; spire short ; whorls three ; aperture below dilate and drawn back.

Hab. Ohio, near Cincinnati. T. G. Lea.
Diam. ·3, Length ·7 of an inch.

Remarks.—A single specimen only of this species has come into my possession. It differs so much from any of the described species, in the dilatation and retraction of the inferior part of the aperture, that I have not hesitated to consider it new.

SYSTEMATIC INDEX

OF

THE SHELLS DESCRIBED IN MR LEA'S MEMOIRS:

VOLUMES III., IV. AND V.

ARTICLE III.

On the Visceral Anatomy of the Python (Cuvier), described by Daudin as the Boa Reticulata. By J. P. Hopkinson, M.D. and J. Pancoast, M.D. Read before the American Philosophical Society November 2, 1832.

THE head having been previously removed, and with it, the commencement of the œsophagus, the account of that part of the animal will necessarily be wanting.

The whole alimentary canal admits of two divisions. The first, comprising the œsophagus and the stomach, extends as low down as the right capsula renalis, and is above five feet in length. The second division is two feet long, may be considered to represent the small and large intestines, and ends at the anus. These two divisions are connected by a smaller transverse canal, which is the pylorus. The œsophagus, at its commencement, is sufficiently capacious to admit both hands expanded. In structure, it is very thin, dilatable, semi-transparent, and, when left undistended, collapses by its elasticity. It passes down, at first on the middle line of the body, having the trachea closely attached to it in front: before reaching the heart it begins to incline to the left, and is then placed between the left lung and the parietes of the body. The structure gradually becomes more dense by the addition of delicate muscular fibres. A contraction is found just above the upper end of the liver, where it is embraced, in the flexuous course of the left aorta, which seems to be the cardiac orifice, for below this point commence the gastric glands or follicles, some of which are of considerable size. The muscular fibres continue to increase in number, until a strong muscular coat is formed, consisting of fasciculi, which are circular within and longitudinal externally. The lower ten inches of the stomach are destitute of the large glands above alluded to. The mucous coat, at this part, is thrown into long rugæ, and the structure itself is very thick and cuts like cartilage. The stomach ends in a cul de sac, diminishing much in size as it terminates. At about half an inch distant from this termination, and passing off at a right angle, is the pyloric portion of the stomach, somewhat resembling that of the viper, as described by Sir E. Home. It is two inches in length, half an inch in diameter, and somewhat curved: the mucous coat of this part is thrown into longitudinal rugæ, and protected externally by strong muscular fibres, but the actual passage is very small. This pyloric portion terminates by joining the second division of the alimentary canal about half an inch below its commencement, projecting into it, to form a circular elevated margin; it is therefore placed transversely across the body, and forms a somewhat indirect communication between the two great divisions of the alimentary canal. In some of this class, a well marked pyloric valve is formed, constituted of an elevated fold of the mucous membrane. The second division, comprising both small and large intestines, is perfectly straight, and begins by a pointed cul de sac, similar to that which formed the termination of the stomach. From its commencement, the mucous coat is completely studded with villi, which are prominent and about a line in length. This intestine enlarges as it descends, and is embraced between the two reflexions of peritoneum, which attach the oviducts. Its greatest diameter is observed about ten inches above the anus, from which point it gradually diminishes as it descends, to accommodate itself to the smaller size of the body. The parietes are thick and firm, although not so much so as those of the stomach. Externally it is marked by several contractions extending the whole length, which produce deep transverse depressions without, and corresponding circular septa within; these septa, or valves as they may be termed, are very numerous, and extend generally around one half of the internal circumference, resembling those in the colon of man. In three or four places, distinct and removed from each other, some remarkable and sudden diminutions exist in the calibre, scarcely large enough to admit the little finger, but which were not accompanied by any corresponding appearance externally. The channel here is oblique, as regards the course of the intestine, and extends for the space of half an inch, so that it is discovered with some difficulty. Such a conformation must very much retard the passage of the food, and in fact absolutely arrest it until perfectly digested; it also may afford the lacteals, by the consequent delay, full time to take up the chyle. In this way nature compensates for the want of a more extensive canal, the protraction of digestion supplying the defect arising from the limited surface of the canal. The lower fifth of this intestine is smooth and nearly destitute of villi, thus presenting the characters of the rectum. At the termination of the rectum, a sudden contraction is made to form the anus, a circular opening, which is placed immediately above the vaginal pouch, being nearer the ventral surface, and further removed from the caudal extremity. The anus is surrounded by some circular fibres, causing the mucous coat here to be puckered into small folds.

BILIARY ORGANS.

The liver is placed on the right side of the spine, and commences at the distance of about two feet and a half from the head; it is fifteen inches in length, oblong and somewhat flattened in shape, of a dark brown colour, and tapers to a point at either end. The peritoneum, which covers it and forms its external coat, attaches it along the back. The vena cava meets it below, and runs in a fossa along the whole length, and in the middle of its anterior or ventral face, leaving it at the top, to go to the right auricle of the heart; it lies beneath the peritoneum, which thus covers the anterior face of it. A multitude of branches is received by this vein from the liver throughout the whole of its course, causing it to augment in size. On the dorsal face of the liver, the vena portæ, coming from the stomach and intestines, is accommodated in a similar manner; but this vessel, in consequence of its distributing branches continually to the gland, diminishes as it proceeds upwards, until finally it is completely disposed of, and terminates as it reaches the top of the liver. The structure of the organ in this instance was soft and rather of a pulpy consistence, perhaps the result of incipient putrefaction. From the lower end, passes off the hepatic duct, almost as large as a crow's quill, but becoming smaller as it descends; this diminution is owing to its giving off many smaller branches in its course, which leave it at acute angles, and then run for some distance parallel with the main duct. Some of them seem to disappear on the parietes of the vena cava; but from their minuteness, although a quicksilver injection was resorted to, their termination was not satisfactorily made out. The principal duct is about twelve inches in length. When it reaches the top of the gall bladder, it divides into several branches, which are spread over its outer surface; some of them open into the cavity of the gall bladder by small orifices, scarcely large enough to receive a fine bristle: four only of these openings were discovered, but probably others existed. The remaining branches, without communicating with the great receptacle of the bile, are collected into a fasciculus, and seem to terminate in a small depression or pit, found at the top of the intestine. The gall bladder is rather more than two inches long, and an inch and a half broad; it is of an egg-like form, having the larger end above, and a small, somewhat conical extremity directed towards the intestine,—it might contain about two ounces. The quantity of bile found did not exceed six drachms; it was of a dark colour, becoming orange when diluted, and slightly bitter to the taste. The apex of the gall bladder was connected to the top of the intestine by a ligamentous chord; but no communication was found to exist between them, and consequently no direct means ascertained by which the bile could escape from the gall bladder when once deposited there—in other words, for the cystic bile to get into the intestinal canal. This was ascertained by allowing the quicksilver to flow from the biliary tubes into the gall bladder, where it accumulated to distention, but found no exit.

PANCREAS.

This gland is small, and is attached to the pyloric portion near its termination, and to the upper end of the intestine at the cul de sac. It is bent upon itself, forming a curve which embraces the cluster of biliary tubes, as they are about entering the intestine. The upper portion is enlarged into a head. The whole gland, when removed and stretched out, measured only two inches. The structure of the pancreas is lobular: the lobes vary in size from one line to three, are of a brownish colour and very numerous; they are connected merely by loose cellular membrane. The excretory tubes proceed from the lobules, run in company with the biliary ducts, and terminate at the same point in the intestine, already described.

SPLEENS.

In this animal there are two spleens, both of which are firmly attached to the parietes of the stomach: the larger, which is also lower down in its position, is three inches long, and an inch and a half broad; the smaller is two inches long and one broad; they are quite distinct, and about an inch apart. A cavity exists in each spleen, which, in the larger, might contain about half a drachm, from which numerous canals pass off in different directions towards the circumference. This cavity communicates with the stomach by a smooth orifice or channel, of the diameter of a crow's quill; a mass of hair, rolled into a ball, occupied the main cavity. The arteries of the spleens come from the gastric, while the veins open into the vena portæ.

URINARY ORGANS.

The kidneys are placed in the fossæ on the side of the spine, reposing upon the ribs. The right kidney is larger, and also placed higher up than the other; the upper end being about one foot nine inches below the liver, while the left is five inches lower. There are about two inches difference in their lengths, and nearly half an inch in their diameters, but in other respects they are precisely alike. The kidney is attached to the parietes by being embraced between the same two laminæ of peritoneum that pass off to surround the oviduct. It is of a dark brown colour, and consists of flattened oblong lobes, about thirty in number—some crescentic, others twisted like the letter S, and connected together by each lobe overlapping its successor. This arrangement commences at each end, and proceeds towards the centre, where the two layers meet. About an inch distant from either extremity, it begins to taper off, and is then suddenly brought to a point. The ureter is placed on the external surface of the kidney; small, at its commencement, it descends along the middle line, increasing continually in its course, and when it leaves the gland has attained the size of a goose quill; from this point to its termination, it is rather more than fifteen inches in length. It opens into the vaginal pouch, by an oblique orifice, situated half an inch lower down than the opening of the oviduct. In immediate connection with the ureter are two veins, like it passing superficially along the whole length of the kidney. One of these, which lies in contact with the lower margin of the ureter, commences below, and increasing as it proceeds, from the continual accession of branches from the gland, passes off from the upper end, and soon after unites with the corresponding vein of the other side, to form the vena cava. The trunk, which lies above the ureter, is reversed in its course, commencing in the ovaria above the kidney, and increasing in size as it descends; it passes along the upper margin of the ureter, and continues to accompany it after it leaves the lower extremity of the kidney. This vein and the ureter pass down together, being connected by the same broad reflection of peritoneum that attaches the oviduct. The two descending veins of the kidneys, like those which ascended to form the vena cava, also unite; this junction, which takes place just below the orifice of the vagina, forms a single vein, that passes down to the caudal extremity. Both before and after the coalition of these two vessels, constant communications, by means of large trunks, are formed between them and the venous circulation on the side of the spine, in which manner it finally terminates. This vein, then, appears to be an insulated vessel; for it originates in small ramifications, in the ovaria, and lobes of the kidney, and seems to have no other destination than to join the great circulation of the spine. This peculiarity suggests the idea, that it is intended to obviate the injurious effects of an impeded circulation when the stomach is distended with food; a distention, from the habits of the animal, likely to be great and of long duration. Under such circumstances, these vessels may, by a circuitous route, carry a large proportion of blood to the heart, which the vena cava alone would be unable to accomplish in a state of partial compression. The emulgent artery is connected with the kidney in the same manner, as were the veins and ureter; it is seen passing from the upper, to terminate at the lower extremity of the gland, being in contact with that vein which forms the origin of the vena cava. It is about a line in its greatest diameter, where it touches the top of the kidney. The capsulæ renales are two long narrow bodies, of a light yellow colour and speckled appearance, being situated above and near the kidneys, but not in contact with them. That on the right side is six inches long, and from one to two lines broad; it comes to a point at each end, and is about three-fourths of an inch distant from the kidney, to which it is connected by the peritoneum. The left capsule is one inch shorter than the other, and is situated lower in the body, but in other respects they resemble each other in all particulars. The capsules and the ovaria lie almost in contact, and are included in the same process of peritoneum.

ORGANS OF GENERATION.

The ovaria are rounded and somewhat flattened bodies of a yellowish colour, and filled with a muddy coloured albumen. They are numerous, and vary from one to six lines in diameter; they are all connected together and arranged in a row, which, on the right, is ten inches long, and on the left eight—the whole forming a curve, the convexity of which is outward on either side. The upper end of the row commences near the fimbriated extremity of the oviduct, which is here drawn in towards their commencement. The oviducts are two in number, and are arranged as follows: that on the right side is three feet three inches in length, the other eight inches shorter, but with this exception they are precisely alike. The oviduct, as it is found in an unimpregnated state, is flaccid and collapsed, being marked by minute transverse folds or wrinkles, which disappear upon distention. Inflation causes this tube to swell out, displaying a most beautiful transparent membrane of wonderful delicacy of structure; it then presents successive enlargements or ampullæ, two or three inches in extent, and contractions, extending an inch or more, interposed between them. The peritoneal attachment is at least four inches in breadth, and is so loose as to allow the oviduct to be spread out from the body on each side; when thus stretched it forms a curve, the broadest part of which is about the middle. The lower portions of the two oviducts rapidly approach each other towards the caudal extremity, and passing on the ventral face of the rectum, proceed on each side of the anus to open by an oval orifice within the upper margin of the vaginal pouch. The upper portions of the oviducts form a curve, whose concavity looks towards the spine, and approach the upper end of the row of ovaria, without, however, touching them. Each upper orifice, or fimbriated extremity as it must be termed, is a free, very distensible opening, one inch in length, forming a sulcus inwards, which terminates in a point; from this point proceeds a well defined edge, two inches long when put on the stretch, formed of peritoneum, and acting as a ligament of attachment. The orifice of the oviduct, therefore, is removed considerably from the ovaria; with this arrangement it is not easy to explain, either, how the semen masculinum arrives at the ovaria, or how the products of impregnation can get into the oviduct. The vagina, common to the ureters and oviduct, is a pouch of a conoidal shape, three inches deep, and an inch and a half in diameter at the external opening, which is also larger and more exposed than the anus. It is placed between the termination of the rectum and the spine, filling up all the space between the ribs at this part. The orifices of the oviducts are oblique, a quarter of an inch in their long diameter, and are placed about an inch apart, within the upper edge of the vagina.

RESPIRATORY ORGANS.

The larynx consists of a single cartilage, having a narrow oblique slit in it, about six lines in length, for the transmission of air; the trachea is one foot eight inches in length, and three-eighths of an inch in diameter, and, as before remarked, passes down attached to the ventral face of the œsophagus. It consists of a great number of imperfect cartilaginous rings, interrupted posteriorly, but joined by an elastic substance which keeps their extremities in contact. Each ring is connected to the adjoining one by a membrane also elastic, so that when the trachea is stretched lengthwise, it will easily regain its former condition. It passes behind the heart, and while there concealed, divides into two bronchiæ, appropriated to the two lungs. The lungs, in a collapsed state, lie much concealed, being covered in part by the liver; but, when inflated, are brought into view, and cause the liver to be raised up. These organs consist in two distinct vesicles or bags, united above along their middle, but terminating below, each in a separate cul de sac. They differ materially in size, but vary less in this respect than those of snakes in general. The right lung is two feet ten inches long, and about four inches broad, and extends down as far as the gall bladder; opposite the spleens, which are on its left, it has a considerable contraction of its diameter. The smaller vesicle lies on the left side, and is loose at its lower end; it is only one foot nine inches long, and three inches broad; it terminates near the lower extremity of the liver. The lower four-fifths of each lung are thin, semi-transparent, and supplied with fewer blood vessels than the upper portion. The parietes are marked by circular lines or striæ, along which are strung small white bodies, apparently vesicular, from half a line to two lines distant from each other; they are much more numerous above, and appear to be merely attached to the inner surface. The upper portion of each lung is composed of a more spongy structure; the parietes are much thicker, and present on their inner surface a loose reticulated texture, somewhat resembling a section of the corpus cavernosum penis, the cells, however, being much larger. A free passage is left through the centre, so that the air, in inspiration, is not obliged necessarily to pass through the cells, which seem to present merely a more extensive surface for the purposes of respiration. Both lungs contained many worms, found most abundant above among the cells, and even in the trachea; they were of various dimensions, being from one to three inches in length, whitish, cylindrical, tapering, and surrounded their whole length by elevated rings or cords.

CIRCULATION.

The heart is situated about two feet from the head, on the middle line of the body; it was flaccid, and contained some firm coagula; it was of an oblong form, and about four inches in length. The two auricles constitute the upper half, and are distinct, having their apices entirely separated above. The right auricle, which is rather smooth internally, receives the blood from the two venæ cavæ. These great veins unite to form a sinus exterior to the auricle, and communicate with it by means of a single narrow opening or slit: this opening is both guarded and formed by two membranous valves, which, in a flaccid condition of the auricle, are loose and movable, but, when the auricle is dilated or stretched, are drawn together like the eyelids, and meeting in a straight line, thus interrupt the communication between the auricle and the sinus. From the right auricle the blood passes into the right ventricle, by an orifice which is small, and situated at the posterior part near the septum of the heart. Within the ventricle, and attached around that portion of the semi-circumference of this opening which is next the septum, a large and loose valve is observed, having in the centre of its floating edge a hard body like the corpusculum Arantii of the human aorta. This valve is placed obliquely as regards the ventricle, is very strong, and when pushed upwards towards the auricle, is found to close the communication with that cavity completely. In this condition of the valve, however, we see exposed on its lower side another orifice, which is that of a free but somewhat oblique passage, going through the septum and opening into the left ventricle. It follows, from the attachment of this valve immediately between these two openings, that in closing the one it exposes the other: that is to say, when it is thrown down so as to allow the blood to descend from the right auricle into the right ventricle, it is placed against the passage leading into the left ventricle, in such a manner as to prevent its entrance into that cavity; on the other hand, when it is elevated, and placed against the opening leading into the right auricle, it leaves free and exposed that which communicates with the left ventricle. The cavity of the right ventricle is marked by some pits or depressions, which are more abundant near the apex, and make its internal surface very irregular. Upon the posterior inferior face of this ventricle, commencing near the apex, and going up to terminate at the roots of the great vessels arising from this cavity, is a fleshy column, attached along one edge to the ventricle, while the other is free; it increases in breadth as it ascends, and forms a partial septum, dividing as it were the ventricle into two cavities. At the point of termination of this column arise three great arteries; two aortæ for the general circulation, and one pulmonary artery which divides to supply the two lungs; they are so placed at their roots, as to form an arch by their lateral connection, and their relative situation is as follows. The left aorta, the smallest of these trunks, is placed in the middle between the other two, and is also the most anterior; it communicates with the ventricle, immediately beneath the fleshy column just described. The pulmonary artery is situated on the left of this vessel, and is much larger than either of the others; it opens into the ventricle, immediately in front of the fleshy column, which therefore intervenes between the orifices of these two vessels, causing the pulmonary artery to hold communication with the anterior cavity of the ventricle, as formed by the column, and the left aorta with the posterior. Immediately behind the root of the left aorta, and much concealed by it, is the orifice of the right aorta,* which is therefore also beneath the column, and connected with the same division of this ventricle; it is intermediate in size to the other two. From this arrangement it follows, that the blood which is thrown out from the right ventricle is divided into two columns, one passing out by the pulmonary artery in front of the fleshy column, and the other by the two aortæ below it. Each of these great vessels is furnished at its root with two semilunar valves, which are calculated to close the orifice of communication with the ventricle, having also two sinuses of Valsalva (as we must term them) to be filled with blood, in a retrograde movement of that fluid. The mechanism, in fact, excepting only in the number of the valves, is like that of the great arteries of the human heart.

The coronary arteries, two in number, arise from the left aorta, and are distributed upon the substance of the heart; the coronary vein, which returns the blood from these arteries, opens into the right auricle. The passage before alluded to, connecting the two ventricles, opens below the fleshy column, near the two aortæ, and, consequently, in direct communication with those vessels. Now, as the blood that is thrown out from the left ventricle, passes directly by that passage into the upper corner of the right ventricle, it is brought at once to

* The terms *right* and *left*, as applied to the aortæ, are meant to indicate the side of the spine along which the artery passes in its descent to the point of junction.

the mouths of the left and right aortæ, which therefore convey pure blood that has passed through the pulmonary circulation. But the pulmonary artery, which is shut out from any communication with the left ventricle by its origin in front of the column, conveys only that blood which was in the anterior portion of the right ventricle, and derived from the right auricle. The left auricle is about one half the size of the right; the septum between the two auricles is membranous and perfect, so that no communication exists between them. One large pulmonary vein opens into this auricle, conveying the blood from both lungs. Below is the opening that leads into the left ventricle; this ventricle is many times thicker than the right, and appears to have less than a third the capacity. At the upper, posterior corner, and in the septum ventriculorum, is the orifice of that passage already described, as establishing a communication between the two ventricles. Between this orifice and that of the left auricle is a large and loose valve, so attached as to close them alternately, as it may be elevated or depressed precisely upon the same principle as explained in reference to the valve of the right ventricle. When this valve is elevated, therefore, it exposes the only outlet belonging to the left ventricle, namely, that passage through the septum which conveys the blood into the right ventricle at the roots of the two aortæ. The right and left aortæ unite at an acute angle behind the lungs, and on a level with the top of the liver, the left having first passed around the œsophagus. The artery that supplies the neck and head is a branch of the right aorta, and comes off from it about two inches from the heart.

VEINS.

The venous circulation is complicated, and consists of four divisions. 1. The vena cava inferior is constituted of branches coming from the kidneys, ovaria, oviducts and liver, being connected with the latter organ, as it passes up to the heart, where it unites with the cava superior, bringing the blood from the head and upper parts of the body. 2. The vena portæ commences in the intestine, spleens and stomach, by branches which, uniting, form a trunk that passes to the liver, and is distributed throughout its structure. 3. Another distinct trunk is formed of branches also commencing in the kidneys, which descends, and, as already explained, terminates in the spinal circulation. 4. On each side of the spine, between the anterior faces of the transverse processes and the sides of the bodies of the vertebræ, passes the vertebral vein already alluded to, which receives the intercostals in its course, and also communicates with the interior circulation of the spinal canal. The ultimate termination and particular forms of these vertebral veins or sinuses, were not satisfactorily made out; it was merely ascertained by a mercurial injection that they ran the whole length of the spine, and formed frequent communications with the vena cava as well as with other veins. A pipe having been fixed in one of the veins of the inferior portion of the body, the quicksilver run out freely from the spinal canal at the cut extremity of the neck, from which the head had been removed; thus, to avoid any particular local congestion, it would seem probable that, through the medium of the double circulation of the kidney, aided by the vertebral veins, the several divisions of the venous system are made to hold free communication.

With much regret was it that we found ourselves obliged to suspend the investigation here. We hope, however, to be enabled at some future time to resume the study of the structure of so interesting an animal, under more favourable auspices, and to do it more justice.

Explanation of the Plate.

A. The Œsophagus.
B. The Stomach.
C. The Pylorus.
D. The Intestinal Canal.
E. The Anus.
F. The Vaginal Pouch.
G. The Liver.
H. H. The Oviducts.
I. The Spleens.
K. The Pancreas.
L. L. The Ovaria.
M. M. The Kidneys.
N. N. The Lungs.
O. The Trachea.
P. The Pulmonary Artery.
Q. The Left Aorta.
R. The Right Aorta.
S. The Common Trunk formed by junction of two Aortæ.

1. Hepatic Duct.
2. Gall Bladder.
3. Renal Capsules.
4. Ureters.
5. Orifices of Ureters.
6. Orifices of Oviducts.
7. 7. Vena Cava.
8. 8. Vena Portæ.
9. 9. Veins descending from Kidneys to Caudal Extremity.
10. Pulmonary Vein.

Fig. 2 is merely a duplicate of the caudal extremity, or lower portion of Fig. 1; and will be understood by a reference to the same letters in the explanation.

ARTICLE IV.

On the Longitude of the Hall of the American Philosophical Society, deduced from an Occultation of Aldebaran observed by S. C. Walker January 5th 1830. Read before the American Philosophical Society October 18th 1833.

On the evening of January 5th 1830, I observed the occultation of Aldebaran at the place mentioned in the Memoir on the Solar Eclipse of February 12th 1831, in the fourth volume of the Transactions of the American Philosophical Society. The local time was estimated from observations of the sun on the meridian, by Joseph Roberts, Jun. at the Friends' Observatory. The telescope used was by Dollond, three and a half feet achromatic. The immersion and emersion were both visible. The same phenomena were observed by Mr Maclear at Biggleswade, England; by Mr Paine at Boston; and Mr Bond at Dorchester, Massachusetts. The immersion was observed at Cambridge, England, by Professor Airy; and at Bedford, England, by Captain Smyth. The observations were as follows:

Occultation of α Tauri, January 5th P.M. 1830.

Immersion.	Emersion.	Observer.	Place of Observation.	Latitude North.	Longitude from Greenwich.
H. M. S.	H. M. S.			° ′ ″	H. M. S.
9 56 15.00 m.*	11 44 30.00 m.	Walker.	Philadelphia.	39 57 01.0	5 00 43.4 west.
10 14 50.50 m.	11 12 19.00 m.	Paine.	Boston.	42 20 38.0	4 44 15.2 west.
10 14 51.00 m.	11 12 50.00 m.	Bond.	Dorchester.	42 19 20.0	4 44 17.0 west.
10 41 53.18 s.†		Smyth.	Bedford, Eng.	52 08 27.6	1 51.97 west.
10 42 44.70 s.	11 33 19.60 s.	Maclear.	Biggleswade, Eng.	52 5 25.0	1 3.50 west.
10 44 07.44 s.		Airy.	Cambridge, Eng.	52 12 10.0	23 54.00 east.

* The letter m denotes mean solar time. † The letter s denotes sidereal time.

This occultation is valuable for the purpose of determining the longitude of Philadelphia, Boston, and Dorchester, from the circumstances of its having been very carefully observed at several established observatories in England. It was selected by Mr Henderson for determining the longitude of Biggleswade and Bedford, and gave the following results.

	By α Tauri, Jan. 5 1830.	By all the Observations to 1832.
	M. S.	M. S.
Biggleswade, west of Greenwich.	1 02.70	1 03.50
Bedford, west of Greenwich.	1 50.60	1 51.97
Bedford, west of Biggleswade.	47.30	48.47

The near agreement of the longitudes deduced from this occultation with the mean of many others, induced me to calculate the longitude of the Hall of the American Philosophical Society from my observations, allowance being made for the place where the observations for local time were made, and for the place where the occultation was observed. The longitude of this Hall, thus deduced, is west from Greenwich, 5 h. 0 m. 46.09 sec.

This longitude exceeds by a few seconds that determined by Rittenhouse from the transit of Venus. It agrees more nearly with the estimates of De Ferrer and Bowditch, and with the recent determination of R. T. Paine from Joseph Roberts' and my observations of the solar eclipse of 1831.

The parallaxes in declination and right ascension were calculated by the method of Maclear, Mem. Ast. Soc. London, Vol. IV., No. XXIX. By this method the errors of the tables of the moon's right ascension are deduced from the star's right ascension, and the moon's tabular declination, independently of the tabular right ascension of the moon.

The longitudes deduced from this occultation by Maclear's method, confirm the remark of Captain Smyth, Ast. Soc. Mem., Vol. IV. p. 567; the west longitude deduced from the immersion being too great, and that from the emersion too small. The mean of the results is however generally accurate.

ARTICLE V.

On the Crystals developed in Vermiculite by Heat. By Andres Del Rio, Professor of Mineralogy in the Mexican School of Mines. Read before the American Philosophical Society November 1st, 1833.

A PUPIL of the celebrated Werner, I have always been more of a Neptunian than a Plutonist, notwithstanding the many crystallizations produced in the dry way. A new instance which has come under my observation in the crystals of vermiculite, has contributed materially to change my opinions.

Dr Meigs first showed me the numerous worm-like filaments which shoot out from this mineral when held in the flame of a candle: it is this property which gives to the mineral its name of vermiculite. Under the blow-pipe, and when exposed on a small capsule to the heat of a fire, the whole mass started up into numerous oblique rhombic prisms, nearly an inch long and more than a line in thickness, crooked and wormlike, like the filaments just referred to. These prisms are composed of very thin plates of the colour and lustre of silver, placed parallel to each other, and oblique to the axes of the prisms. I also observed some twin crystals among these groups.

These crystals were digested in sulphuric acid, which separated the plates from each other, probably by dissolving out portions of the mineral which were between the plates; these latter remained unattacked by the acid. A partial examination of the solution, made at my request by professor Bache, yielded much alumina, some lime, lithia and oxide of iron, but neither magnesia nor potash. It is possible that the vermiculite, which bears the appearance of a decomposed mineral, has lost part of its potash and silex, like the porcelain earth; and that the remaining part combines under the influence of heat in proper proportion to form the plates, while a portion containing no potash remains interposed between them.

These crystals then are probably a potash and lithia mica, of which the crystalline form indicates two axes of refraction, and the constituents of which, being contained in the vermiculite, are combined and crystallize suddenly by the action of heat; the reverse operation of crystallizing by cooling.

The formation of mica in the minerals of Mount Vesuvius may be explained on similar principles, though in that case we have a magnesian mica, with a single axis of refraction.

ARTICLE VI.

Collections towards a Flora of the Territory of Arkansas. By Thomas Nuttall. Read before the American Philosophical Society April 4, 1834.

CRYPTOGAMIA.

Or Sporadia. Gemmule and perfect plant consimilar; sexual organs and flowers heteromorphous and inconspicuous; cotyledons none.

FUNGI.

1. Fuligo *flava.* 2. F. *cinnabarina.* 3. F. **coccinea.*—*Hab.* The trunks of Cupressus disticha.

1. Trichia *botrytis.* 2. T. *vulgaris.* 3. T. *reticulata.*

FILICES.

Ophioglossum *vulgatum.*—*Hab.* Near the town of Arkansas.

1. Botrychium *fumarioides.* 2. B. *obliquum.*—*Hab.* Of frequent occurrence in shady woods.

1. Osmunda *spectabilis.* 2. O. *cinnamomea.*—*Hab.* Near springs on the banks of Arkansas and Red rivers, but not common.

1. Polypodium *vulgare.* 2. P. *incanum.*—Common.

1. Aspidium *acrostichoides.* 2. A. *marginale.* 3. A. *Filix femina.*

1. Asplenium *rhizophyllum.* 2. A. *angustifolium.* 3. A. *ebeneum.* 4. A. *melanocaulon.* 5. A. *Ruta muraria.*

Pteris *aquilina.*

Woodwardia *virginica.*

Adiantum *pedatum.*—*Hab.* Near the Petit Gulf on the banks of the Mississippi.

Cheilanthes *vestita.*—Common.

Pilularia.

Marsilea * Remotely allied to the Ferns. Natural affinity unknown.

Azolla *Americana.*

Equisetum *hyemale.*—*Hab.* Forming extensive and exclusive fields on the banks of the Ohio, Missouri, Mississippi and Arkansas rivers.

Chara *vulgaris.*

PHÆNOGAMIA.

Or Seminifera. Germinal rudiments and succeeding vegetation dissimilar; sexual organs and flowers conspicuous.

ACOTYLEDONES.

NAIADES.

1. Lemna *minor.* 2. L. *polyrhiza.*

1. Callitriche *verna.*

2. C. **pedunculosa*, foliis omnibus ellipticis, enerviis; fructibus pedunculatis, declinatis.—*Hab.* (In depressed situations, and on the margin of ponds, attached to the ground) from Arkansas to the Pottoe, &c.—*Obs.* Leaves cuneate-elliptic, thickish and covered with impressed punctures; flowers axillary and opposite, monoicous, one of them staminiferous; calix and corolla none? (at least I could not discover any); stamens not exserted; styles two, for a while persistent on the summit of the pedunculated fruit; seeds four, compressed; time of flowering, February.

3. C. **peploides*, subcæspitosa; foliis omnibus ellipticis; fructibus sessilibus.—*Hab.* On the banks of the Mississippi, and on the margins of ponds. This species differs from the preceding by the greater minuteness and sessile posture of the fruit; the stems are also perfectly erect. It cannot well be confounded with the heterophyllous and floating species, as it shows no tendency to either one or the other. The great extent of its geographical distribution, every where along the banks of the Mississippi and the neighbouring ponds, proves it to be no transient or local variety, influenced by peculiar circumstances.

Ceratophyllum *submersum?*

1. Myriophyllum *spicatum*. 2. M. *heterophyllum*. 3. M. *scabratum*.—*Obs.* Fruit with eight furrows, and the ridges muricate.

Proserpinaca *palustris*. The quadration of the parts of fructification which frequently happens in this genus, besides the great similarity of habit, renders it inseparable in order from Myriophyllum.

1. Potamogeton *natans*. 2. P. *heterophyllum*.

Obs. The genera Myriophyllum, Ptilophyllum and Proserpinaca (probably terminating with two cotyledons) would, perhaps, have been more properly arranged with the first section of the Onagrae of Jussieu. Proserpinaca has been heretofore associated with the Hydrocharideae.

AROIDEAE.

Saururus *cernuus*.—*Obs.* Stamens on the lower, and as far as above the middle of the spike, eight, seven and six, uppermost flowers often producing only four. This genus is collated with the Peperomia of Ruiz and Pavon, and we cannot perceive any sufficient reason for excluding the genus Piper from this natural association. The only obstacle appears to be the quadrature of the germs in Saururus, which, however, precisely agrees with the increased number of stamens, eight in place of two, and so four fruit in place of one. The sensible taste and aroma of Saururus is similar to that of Acorus calamus.

1. Arum *triphyllum*. 2. A. *dracontium*.—*Hab.* Near the Cadron settlement.

Neither Symplocarpus nor Orontium appears to the west of the Alleghany mountains.

ACORUS *calamus.*—*Hab.* From the town of Arkansas to the Pecannerie settlement.

TYPHA *latifolia.*

CYPEROIDEAE.

1. CAREX *rosea.* 2. C. *tentaculata.* 3. C. *lupulina.* 4. C. *flava.* 5. C. *folliculata.* 6. C. *plantaginia.* 7. C. *anceps*, &c.

SCLERIA *reticularis.*

FUIRENA *squarrosa.*—*Obs.* The root in winter becomes bulbous.

SCIRPUS *trichodes.* 2. S. *palustris.* 3. S. *lacustris.* 4. S. *quadrangulatus.*—Rare. 5. S. *autumnalis.*

1. RHYNCHOSPORA *alba.* 2. R. *longirostris.*

1. SCHOENUS *setaceus.* 2. S. *effusus.*

1. MARISCUS *retrofractus.* 2. M. *echinatus.*

1. CYPERUS *poaeformis.* 2. C. *pygmaeus*, Cavan. ic. 6, p. 65, t. 568, f. 2; C. *uncinatus Ph.*—Scarcely distinct from C. squarrosus of India. 3. C. *brizaeus.* 4. C. *flavescens.* 5. C. *hydra.* 6. C. *flavicomus.* —*Obs.* The roots of several of these species become fragrant when dried.

KYLLINGIA *pumila.*—*Hab.* Banks of the Mississippi.

GRAMINEAE.

LIMNETIS *cynosuroides.*

GREENIA.* Calix coriaceus, oblongus, bivalvis, uniflorus; corolla inclusa, bivalvis; valva exteriore sub apice integra aristata; perisporium bipartitum. Panicula multiflora, subracemosa; stipulis membranaceis.

G. *Arkansana.* Root fibrous, annual? Culm about twelve to eighteen inches high; leaves short and narrow, often pubescent; stipules membranaceous; panicle slender, partly racemose. Calix indurated; valves oblong, scabrous, semiterete and acute, awnless, including the corolla; valves of the corolla linear-oblong, acute, naked at the base; the exterior awned below the summit, which is entire; awn at first straight, about twice the length of the corolla, spirally twisted by desiccation, persistent.

* In honour of B. D. Greene, Esq. well known as an assiduous botanist.

Allied to Oryzopsis.—*Hab.* On the calcareous hills in the grassy plains of Red river. Flowering in May.

1. MUHLENBERGIA *diffusa.*—Called nimble-will, and considered as an important pasture-grass in Kentucky and Tennessee. 2. M. *erecta.*

1. AGROSTIS *tenuiflora.* 2. A. *stricta.*

3. A. *arachnoides*, Elliott. Panicula patente, capillari; floribus binatis, glabris; corolla, arista dorsali tenuissime capillacea longissima; foliis brevibus planis.—*Hab.* In the open and elevated prairies of the Arkansas. Flowering in April and May.—*Obs.* Culm about a span in height; branchlets of the panicle few-flowered, capillary and flexuous; flowers aggregated towards the summits of the branchlets, commonly purple and somewhat shining; calix lanceolate, the carina scabrous; corolla 2-valved, a little shorter than the calix; awn of the dorsal valve about four times its length, appearing like a flaccid silken hair; anthers three. This very curious grass, which occurs sometimes according to Mr Elliott with a single stamen, appears to be somewhat allied to the genus Jarava.

4. A. *decumbens.* 5. A. *vulgaris.* 6. A. *clandestina.*—*Obs.* This appears to be the Panicum clandestinum of Persoon. 7. A. *Indica.* —*Hab.* Banks of the Mississippi, as far as New Orleans.

1. TRICHODIUM *laxiflorum.* 2. T. *decumbens.*

CINNA *arundinacea.*

1. CALAMAGROSTIS *Canadensis.*

2. C. **gigantea.* Panicula pyramidata, ramis multifloris; calicibus lanceolatis membranaceis corolla mutica breviori, valvulis inaequalibus. —*Hab.* On the sandy banks of Great Salt river of the Arkansas.—*Obs.* The great magnitude and general aspect of this species might justly entitle it to the common appellation of a reed, notwithstanding the calix containing only a single flower. They grow also in considerable quantities together. The culm, of a proportionate thickness, often attains the height of six feet. The leaves, which are smooth, are considerably attenuated towards the point; the stipules are a mere margin of dense hairs. The panicle is sometimes nearly as much as a man can fathom, consisting of many effuse branches, forming a pyramidal panicle. The flowers are somewhat racemosely aggregated by pairs; the valves of the membranaceous calix are lanceolate, unequal

in length, perfectly smooth, and each furnished with a single nerve terminating somewhat acutely; the corolla is altogether similar, except that the valves are somewhat pubescent on the back, and the base furnished with the conspicuous wool of Arundo.

POLYPOGON *racemosum.*

ALOPECURUS *geniculatus.*

PHALARIS **occidentalis.* Panicula spiciformi, ovata; glumis carinatis lanceolatis integris glabris; corolla 4-valvi; valvulis exterioribus subulatis, interioribus villosis.—*Hab.* In partially inundated prairies, from fort Smith on the Arkansas to Red river. Flowering in May.—*Obs.* Annual. Culms fasciculated, about twelve inches high; root fibrous; leaves four or five, broad lanceolate, acute, pale green and smooth, but scabrous along the margin; stipules membranaceous, lacerate; spike solitary, terminal, at first included in a ventricose sheath, cylindric and smooth; glumes of the calyx exceeding the corolla in length, navicularly compressed and pungently acute, of a texture partly hyaline, with green veins, the keel a little hispid; corolla ovate, acute, pubescent, 4-valved, the exterior valves minute and subulate. Nearly allied to P. canariensis, of which it possesses the entire aspect, but the flowers and seeds are very much smaller, and indeed altogether distinct. Doctor B. D. Greene found this species in Cuba, and Doctor Little discovered it in the vicinity of New Orleans.

1. PANICUM *crus-galli.* 2. P. *gibbum,* Elliott. 3. P. *geniculatum.* 4. P. *anceps.* 5. P. *hians.* 6. P. *virgatum.* 7. P. *latifolium.* 8. P. *pauciflorum.* 9. P. *multiflorum.* 10. P. *pubescens.* 11. P. *ciliatum.* 12. P. *microcarpon.* 13. P. *angustifolium.* 14. P. *capillare.* 15. P. *agrostoides.*

Obs. The Panicum milium and P. Italicum deserve to be cultivated in the warmer states and territories of the union, particularly where wheat is found not to succeed, as is the case in the Arkansas territory, and as I have understood also in the warmer parts of Tennessee or Kentucky. In Africa and tropical America the Panicum jumentorum, called Guinea grass, is also an object of cultivation.

PENNISETUM *glaucum.*

ORTHOPOGON *parvifolium.* Vide Appendix to Nuttall's Genera of American Plants.

1. DIGITARIA *sanguinalis*. 2. D. *filiformis*.

CYNODON *dactylon*.—*Hab*. Banks of the Mississippi, near Fort Adams and Natchez.

1. PASPALUM *setaceum*. 2. P. *laeve*. 3. P. *purpurascens*, Elliott.

4. P. **racemosum*, villosum; spicis alternis, brevibus, culmo appressis; rachi pilosa immarginata; floribus bi-seriatis.—*Hab*. The grassy plains of Red river. Flowering in June.—*Obs*. Perennial; leaves short, narrow and softly pubescent; culm somewhat naked, eighteen inches to two feet high; spikes about five, disposed in a simple raceme; rachis without margin; clavellate receptacle of the flowers pilose; calix villous, outer valve 5-nerved.

5. P. *stoloniferum*.—*Hab*. Inundated banks of the Arkansas and Mississippi.

CENCHRUS *tribuloides*.

TRIPSACUM *dactyloides*. A common grass throughout the plains of the Arkansas territory, and an important nutriment to cattle. This species is not apparently distinct from the monostachyon, as there are all gradations, from one to several spikes.

1. STIPA *avenacea*. 2. S. *parviflora*. 3. S. *sericea*.

1. ARISTIDA *stricta*. 2. A. *oligantha*. 3. A. *dichotoma*. 4. A. *pallens*.

5. A. **purpurea*. Panicula erectiuscula gracili; cal. valvulis remotis aristulatis apice bifidis; aristis capillaribus longissimis; foliis brevibus scabris.—*Hab*. On the grassy plains of Red river, in arid situations. Flowering in May.—*Obs*. Perennial; leaves narrow, short and scabrous; ligula pilose; culm about one foot high; panicle many flowered, a little spreading, branches capillary; flowers commonly in pairs (after the manner of the genus), bluish purple; one valve of the calyx nearly double the length of the other, both bifid at the summit and shortly awned, the longer valve exceeding the corolla; awns equal, capillary, nearly three times the length of the corolla and scabrous; corolla minutely stipitate.

AIRA *obtusata*, Mich. (A. mollis, Muhlenberg).

URALEPSIS *aristulata*.—On all the sand-bars of the Arkansas; common.

1. POA *pratensis*. 2. P. *annua*. 3. P. *viridis*. 4. P. *nemoralis*,

β debilis. 5. P. *fluitans.* 6. P. *capillaris.*—*Obs.* The whole plant asperate; lower spikelets 3 to 6-flowered, upper ones bearing from 10 to 12; the base of the branchlets tumid and pilose; leaves much shorter than the culm; spikelets purple. Is the P. hirsuta of Michaux essentially distinct from this species?

7. P. **trichodes.* Glabra; panicula maxima elongata, capillari; spiculis laxis lanceolatis planis 3—8-floris acutis; foliis longissimis. Perhaps P. *tenuis* of Elliott.—*Hab.* In bushy prairies and open alluvial lands.—*Obs.* Perennial; three to four feet high; leaves very long and rather broad, smooth, occasionally pilose at the orifice of the sheath; stipules none; panicle one to two feet long, innumerably branched, capillary, divided; spikelets smooth, upon long pedicells; the lower ones 3 or 4-flowered, the upper with 8; calix and corolla carinate, very acute and smooth, almost membranaceous; florets not crowded nor tomentose at the base; dorsal valve 3-nerved; stamens three, pale coloured.

8. P. *conferta* (P. glomerata, Walter, not of Linnæus).—On the inundated banks of the larger rivers. 9. P. *parviflora.* 10. P. *eragrostis.*

11. P. **interrupta.* Panicula laxa, interrupta; spiculis glomeratis, subsessilibus, oblongo-lanceolatis, compressis, multifloris (8—16), valvulis acutissimis; foliis angustatis.—*Hab.* In bushy prairies, near the sandy banks of the Arkansas; common.—*Obs.* Perennial; plant glaucous; leaves narrow; ligula pilose, obsolete; culm twelve to eighteen inches; branches of the panicle somewhat remote and divided, partly erect; spikelets conglomerated, carinately compressed, appearing serrated; valves ovate, acute, 3-nerved (after the manner of this section of the genus, which I have elsewhere termed Brizoma). A very elegant and well characterized species. Flowering in June.

12. P. *pilosa* (P. tenella, Elliott and Nuttall; P. pectinacea? Michaux). 13. P. *hypnoides.*—Abundant and common along the inundated banks of the Mississippi. 14. P. *reptans.*

15. P. **capitata.* Dioica, viscido-pubens; culmo reptante; panicula foeminea subrotunda lobata obtusa, mascula conferta; spiculis subduodecemfloris, lanceolatis; foliis distichis brevibus.—*Hab.* On the sand-beaches of the Arkansas. Flowering in July.—*Obs.* Allied to

P. reptans, but remarkably distinguished by its conglomerated and almost capitate panicles, which give it almost the appearance of Crypsis aculeata. Annual and pilose; culm prostrate, diffusely branched, striking root at the nodes; leaves lanceolate and very acute, distichal, about two inches long; sheaths very short; stipules obsolete, pilose; female flowers spiked, the spikes subcapitate and lobed; male panicle acute, the spikelets less crowded, compressed, larger than those which are styliferous, and all 3-nerved after the manner of this section, with which it arranges.

1. Windsoria *poaeformis* (Poa sesleroides, Michaux).

2. W. **stricta.* Panicula subspicata, stricta, multiflora; calicibus acuminatis, spiculis subquinquefloris paulo brevioribus.—*Hab.* In prairies, near the town of Arkansas.—*Obs.* Perennial; leaves long and smooth; stipules pilose; culm about two feet high, rigid, 1 or 2-jointed; panicle six to eight inches long, crowded with numerous and short branchlets, appressed to the culm so as almost to resemble a spike. Calix acuminate, nearly the length of the spikelet; each valve with a single nerve or vein; dorsal valve of the corolla (as usual) densely villous along the lower margins and back, subtricuspidate, the central cusp alone conspicuous.

Danthonia *spicata.*

1. Festuca *tenella*, *β* **glauca*, culmis numerosis foliosis.—*Hab.* Fort Smith. 2. F. *elatior.* 3. F. *polystachia.* 4. F. *diandra.* 5. F. *fluitans.*

6. F. **sciurea.* Panicula spicata elongata; calicibus subæqualibus 5—7-floris; floribus pubescentibus longissime aristatis; foliis setaceis brevissimis.—Arkansas.

1. *Diachroa. Corolla carinata, substipitata, membranacea; valvula exteriori sub apice aristata, dorso margineque utrinque barbata.

2. D. *procumbens* (Festuca procumbens, Muhlenberg).—*Obs.* Annual. Culm prostrate, compressed, smooth, the panicle ascending; leaves scabrous, long and attenuated; stipules membranaceous, lacerated; panicle partly included in the leaf-sheath, the rachis scabrous and angular, branches undivided and rigid, also angular; spikelets alternate, subsessile, crowded; calix 2-valved, 8 to 9-flowered, valves unequal, acute, 1-nerved; corolla 2-valved, æruginous-purple; dorsal valve cari-

nated, 3-nerved, shortly awned, sericeously ciliated towards the base; florets stipitate, the stipe sericeous; stamina three; anthers small, pale yellow; stigmas white, filiform and simply plumose.—*Hab.* On the sands of the ocean, along the sea coast of New Jersey, &c., and on the sand-bars of the Arkansas for more than a thousand miles. The whole aspect of this plant is at variance with Festuca, and it ought, apparently, to constitute a distinct genus.

1. Koeleria *tuberosa?* Persoon (Aira cristata, Smith).—*Obs.* Root perennial, fibrous; leaves smooth or pubescent; stipules membranaceous; panicle in the form of a spike, from four to six inches in length; rachis pubescent; flowers crowded; calix oblong, 2 to 3-flowered, greenish and shining.—*Hab.* On the plains of Arkansas and Red rivers.—Common. K. nitida, Nuttall's Genera Am. vol. 1, p. 74.

2. K. *paniculata*, Nuttall's Gen. Am. Appendix. (Aira truncata, Muhlenberg; Aira obtusata, Elliott, not of Michaux?)

Bromus *purgans* (B. ciliatus, Lin.).—*Obs.* Leaves partly distichal.

1. Uniola *latifolia.* 2. U. *gracilis.*

3. U. **multiflora.* Panicula subspicata rigida; spiculis longissimis lanceolato-linearibus numerosissime floris; culmo brevi, a basi ramosa; foliis subdistichis subulatis brevibus.—*Hab.* On the sand beaches of the Arkansas, above the garrison.—*Obs.* Perennial; culm terete, radicant and divided towards the base; leaves alternate, distichally spreading, rather short and subulate, pale green; sheaths short, commonly pilose at the orifice; stipules obsolete; panicle spiked, branchlets short and appressed; calix 2-valved; spikelets often an inch long, and scarcely more than a line and a half wide, containing from sixteen to twenty-four florets; external corolla, valves ovate-acute, concave, opaque and smooth, numerously striate and scariose along the margin; anthers three, yellow; many of the glumes abortive of seed. This species possesses all the habit of U. spicata, but differs essentially by the magnitude and paucity of the spikelets. I have a specimen which I collected on the plains of the Missouri, apparently referable to this species, but the spikelets are ovate, and not more than about 12-flowered.

1. Melica *glabra*, Mich. (M. racemosa, Muhl. Gram. Descript. p. 88).

2. M. **scabra.* Foliis latis subpubescentibus asperis; panicula

ramosa, multiflora, ramis subsimplicibus; floribus secundis nutantibus; calicibus trifloris; floribus glabriusculis exsertis.—*Hab.* In the humid shady woods of Cedar prairie, ten miles from Fort Smith. Flowering in May.—*Obs.* Perennial. Culm two to three feet high; stipules lacerate; panicle many flowered, secund, partly branched to the summit; calix mostly 3-flowered, besides the neutral rudiment, which is pedicellate; valves ovate, obtuse and coloured, with the margin scariose; spikelets sublanceolate, the flowers being exserted beyond the calix; flower glumes striated, merely smooth to the naked eye; inner valve (seen through a common lens) pubescent along the margin, as in M. glabra, to which this species is proximately related; stamens three; styles two, pubescent. This species appears to be somewhat related to M. aspera of Barbary.

1. Miegia *gigantea* (M. macrosperma, Pursh).—Ramis floriferis, spiculis paucifloris (8—10), purpureis, glabris, acuminatis; caule fruticoso altissimo.—*Hab.* From Great Sandy river on the northern confines of Kentucky, along the alluvial borders of the Ohio to its confluence; on the banks of the Mississippi, from Kaskaskia to the Gulf of Mexico; on the borders of the Arkansas, a few miles above the Verdigris; on Red river to the L'eau Bleu; in the Atlantic states to the confines of Virginia. When, after a lapse of years, arrived at the period of flowering, it often sends up in a period of two months a stem of thirty-five or forty feet in height, which in the following year flowers and dies. This species rarely survives after being cut down, while the smaller or dwarf cane springs up again from the remaining root.

2. M. **pumila.* Panicula radicali; spiculis pubescentibus, multifloris (12—20), valvulis longe acuminatis.—*Hab.* At the confluence of Kiamesha and Red rivers, in alluvial lands.—*Obs.* Culm three or four feet high, shrubby and slender; leaves as in the preceding, but somewhat broader; flowering panicles radical, two to three feet high, slender, and often refracted towards the summit; spikelets slenderly pedunculate, and attenuated at the base, two to three inches long and pubescent, containing from ten to twenty conspicuously acuminated or cuspidate flowers; calix small, with very unequal valves; stamina three; stigmas three; sheaths of the leaves pubescent along the margin; the orifice surrounded by setose tufts. I am not certain that this plant is

the dwarf cane commonly noticed by the colonists, which indeed appears to be nothing more than a variety of the M. gigantea.

Chloris ***verticillata.* Spicis plurimis verticillatis, radiatis, filiformibus; calicibus acuminatis bifloris; flosculis longe aristatis; gluma exteriore subbarbata; caule compresso.—*Hab.* On the sandy banks of the Arkansas, near Fort Smith; rare. Flowering in June.—*Obs.* Perennial. Culm compressed, branched from the base, about twelve inches high; leaves pale green, narrowish and flat; sheaths carinately compressed; stipules obsolete, hairy; spikes mostly verticillated in two series, the first aggregation consisting of from seven to nine spikes; spikes filiform and stellately spreading, pilose at the base, about six inches long; flowers unilateral, alternating in two rows; calix acuminate, 2-flowered, one of the flowers perfect, the other neuter, the dorsal valves of both gibbous, obtuse and awned, the awn more than twice the length of the flower, that of the hermaphrodite bearded; seed triangular, smooth and even; anthers three; stigmas two, brown. There are few grasses in America more curious and elegant. Its aspect is that of the tropical species.

Oxydenia *attenuata* (Eleusine sparsa, Muhl. Gram. Descript. p. 135). The Chloris mucronata of Michaux appears to belong to this genus, and is evidently distinct from the plant of Pursh and Muhlenberg, which has digitate spikes, is more nearly related to Chloris, and forms the genus Dactyloctenium of Wildenow and Sprengel.

Eleusine *Indica.*—*Hab.* The banks of the western rivers in the United States appear to be the only genuine locality of this intrusive grass, which, from the coast of the Atlantic to the garrison of the Arkansas, uniformly infests gardens, court yards, and in the towns even the pavements of the streets. Bearing to be trampled upon without injury, it thus occupies places where scarcely any other vegetable can subsist. As it is equally common to India, the West India islands and North America, it probably extends through both hemispheres.

1. Atheropogon *apludoides* (Chloris curtipendula, Michaux).—Throughout the western country in elevated prairies.

2. A. *olygostachyum*, Nuttall's Gen. Am. vol. 1, p. 78.—*Obs.* The spikes in these more perfect specimens than those which I collected in the Missouri territory, are commonly three in number, and, after the manner of the genus, alternately disposed along the rachis for a distance of about three inches, including the terminating one. This species

possesses very much the appearance of the Monocera of Elliott (Chloris monostachya, Mich.).

Hordeum *pusillum*, Nuttall's Gen. Am. vol. 1, p. 87. The specimens which I collected in Cedar prairie, a few miles from Fort Smith, are scarcely less than twelve inches high, while those of the arid plains of the Missouri were not more than five or six.

1. Elymus *Canadensis*. 2. E. *virginicus*.

1. Asprella **Americana*. Spica erecta, spiculis patentibus, superioribus subunisetis.—*Obs.* In the American plant the upper spikelets are subtended by one or two longish setaceous portions of an involucrum, entirely wanting in the European species.

2. A. **angustifolia*. Spiculis pubescentibus, involucrum nullum.

Spartina *polystachya* (Limnetis polystachya, Persoon, and apparently L. cynosuroides of the same). This grass, though common on the sea coast, exists in wet prairies throughout the Missouri and Arkansas territories to their utmost limits.

Rottboellia **campestris*. Spica solitaria subcylindrica glabra; floribus subsecundis geminis sterilibus pedicellatis; valvula calycina ovata, punctata; corolla trivalvi.—*Hab.* In open grassy prairies, abundant. Flowering in June.—*Obs.* Perennial. Culm two to three feet high, smooth and erect, rarely terminating in more than a single spike; leaves narrow and rather short, commonly smooth to the naked eye; ligules minute and membranaceous; spike pedunculate, about six inches long, nearly cylindric; rachis flexuose and scrobiculate; calix of the perfect flower consisting of one external and one internal valve; corolla of three membranaceous valves. The rudimental flower minute and neutral, its pedicell appressed to the scrobiculum of the rachis; anthers three; styles two, brown and plumose. This species appears to be allied to R. coalorachis of the isle of Tanna, according to the description of Forster, which is not sufficiently complete to admit of decision. It appertains to the section which, in my account of the North American genera, is termed Apogon, from their affinity to Andropogon. As in R. rugosa there described, the corolla consists of three valves.*

* By an oversight in the printing of the above mentioned book, in the fourth line of the specific description, page 84, the word "corolla," which ought to precede "3-valved," has

Lepturus *paniculatus*, Nuttall's Gen. Am. vol. 1, p. 81.—In denudated places in the open prairies; common, and rather larger than the Missouri plant.

1. Anthopogon *lepturoides* (Andropogon ambiguum, Michaux). Racemis e basi floriferis; calicibus subbifloris; floribus nudis longe aristatis; foliis ovato-lanceolatis.—*Hab.* Near the Cadron, in open woods.—*Obs.* In the most perfect natural specimens the calix contains two flowers besides the rudiment.

2. A. **filiforme*, racemis gracillimis superne floriferis; calicibus unifloris; valvula exteriore ad marginem barbata, arista brevissima; foliis sublanceolatis brevibus.—*Hab.* In shrubby prairies near the banks of the Arkansas. I first detected this very distinct species on the bushy margins of swamps in Sussex county, Delaware, a few miles from Lewistown, in September 1818.—*Obs.* Perennial; culm slender, below the panicle, as in the other species, rather crowded with somewhat distichally disposed leaves, which are, however, much shorter and narrower; panicle virgate, and the branchlets very slenderly filiform (about fifteen to twenty, in the preceding species often thirty), producing flowers only towards the summit; flowers minutely pedicellate, appressed to the rachis; calix acuminate, scabrous, 1-flowered; corolla glume lanceolate, the margin of the outer glume bearded; the awn scarcely half the length of the valve; neutral rudiment setiform and included.

1. Erianthus *alopecuroides*. 2. E. *contortus*, Baldwyn in Elliott's Sketches Bot. Carol. p. 40.—*Hab.* On shelving rocks along the banks of the Arkansas.

1. Andropogon *virginicum*. 2. A. *macrourum*.

3. A. *avenaceum*.—This species is very generally considered the

been omitted; for which casualty I conceive myself by no means deserving of the injurious sarcasms which it has occasioned. In the detailed description of the same plant I had also ventured to consider the third valve of the corolla as a neutral rudiment of a second flower, an inference which numerous analogies in the vegetable kingdom, and particularly in the Gramineae, sufficiently warrant as just and accurate. In the genus Panicum this abortion of the sexual organs is even the essential character of the genus. But to answer every ill-natured cavil which might be brought against the descriptions of natural objects, or to expect an uniformity of conception, any more than in the characters of the objects themselves, would be attempting something more than human and only adding folly to weakness.

same as the A. nutans; it appears, however, to be sufficiently distinct, and occupies a more northern range. The panicle of the A. avenaceum of Michaux is erect and fewer flowered, the flowers are larger and the awn about half the length of that of A. nutans, the rufescent colour also described by Michaux is very constant and belongs to the pubescence, which in the other species is yellowish. A. avenaceum is the A. ciliatus of Mr Elliott. Although these two species differ in habit, yet they agree in structure precisely with the genus Andropogon. I can perceive no possible reason to refer A. nutans to the genus Anthisteria, as has been done by Persoon.

1. LEERSIA *virginica.* 2. L. *oryzoides.*

1. ZIZANIA *aquatica.* 2. Z. *miliacea.* This species is to me very rare. I first recognized it near to the Great Salt river of the Arkansas. Although there is an admixture of fertile and infertile flowers, yet the former, as in the common species, pretty generally occupy the summit of the panicle.

JUNCEAE.

1. JUNCUS *effusus.* 2. J. *bicornis.*

3. J. **heteranthos.* (Culmis foliosis); foliis planis glabris, corymbo terminali prolifero, capitulis subtrifloris; foliolis caliciuis exterioribus brevioribus acutis, interioribus obtusis, capsulam obtusam aequantibus; stamina tria.—*Hab.* In the woods of the Arkansas.—*Obs.* Culm slender and compressed, about three feet high; leaves very smooth, flat, longitudinally nerved and acute, scattered to the summit of the culm; panicle small, consisting of several corymbose and proliferous branchlets; flowers mostly by threes and triandrous; stamina coming out from the base of the three shorter and acute segments of the calix; seeds numerous and minute. Closely allied to J. marginatus.

4. J. *polycephalus.* 5. J. *acuminatus.* 6. J. *tenuis.* 7. J. *bufonis.* 8. J. *repens.*

LUZULA *campestris.*—*Hab.* Near the town of Arkansas.

TOFIELDIA *glabra,* Nuttall's Gen. Am. vol. 1, p. 235 (T. glaberrima? Elliott, Flor. Carol. p. 424).—*Hab.* In the prairies near Arkansas. I am by no means certain whether the plant discovered by the late Mr M'Bride, and described by Mr Elliott, be the same with that which I found in the vicinity of Wilmington, North Carolina. The T. glaberrima attains the height of two or three feet, and bears a spike five or six inches in length; the petals are also oblong instead of ovate, and the styles distinct. As far as I yet know, they appear to be distinct species.

1. Helonias *erythrosperma.—Hab.* Near Arkansas, in prairies. 2. H. *angustifolia.*—Root bulbous, leaves not remarkably long; stamens exserted; anthers yellow; seeds angular, subovate.—*Hab.* Near Fort Smith.

Melanthium *virginicum.*

1. Veratrum *luteum?* 2. V. *angustifolium.—Hab.* In the woods of Arkansas and Red rivers.

PALMAE.

Sabal *Adansoni* (Rhapis acaulis, Willd. vol. 4, p. 1093). This palm first makes its appearance a few miles below the southern boundary of the Arkansas territory, along the banks of the Mississippi. There is a variety of it which forms a caudex twelve or eighteen inches above ground, bearing leaves of nearly double the usual dimensions, and a proportionably tall spadix.

SMILACEAE.

1. Smilax *rotundifolia.* 2. S. *sarsaparilla.* 3. S. *tamnoides.* 4. S. *lanceolata.* 5. S. *herbacea.*

Dioscorea *quaternata.*

Gyromia *virginica* (Medeola virginica, Linn.).

1. Trillium *sessile.—Obs.* Of this species there are a northern and southern variety, which vary in their time of flowering and magnitude. β praecox, petals cuneate-ovate, about the length of the calix. —*Hab.* From Louisiana to North Carolina. γ boreale, petals lanceolate, longer than the calix, flowers later. T. sessile, Pursh, 1, p. 244. —*Hab.* In Pennsylvania.

2. T. **unguiculatum.* Flore sessili, erecto; petalis ovatis, unguiculatis; calicibus reflexis; foliis petiolatis, lato-ovatis, acutis.—*Hab.*

In the shady woods on the banks of the Arkansas.—*Obs.* Leaves blotched, flowers brown, and the whole aspect, specific character excepted, that of T. sessile.

3. T. **viridescens.* Flore sessili, erecto; petalis lineari-lanceolatis longissimis, calicibus patentibus; foliis sessilibus lato-ovalibus, subtus ad basin puberulis.—*Hab.* In shady woods at the Dardanelle settlement. Flowering in April.—*Obs.* Stem purple, pubescent near the juncture with the leaves; leaves large, broad-oval and acute, mostly blotched, closely sessile, beneath towards the base of the nerves pubescent; calix spreading, not reflected as in the preceding, segments ovate-lanceolate, greenish, the lower part inclining to brown, one and a half to one and three-fourths inches in length; petals lanceolate-linear, purplish-green, the claws brown, two to three inches in length; anthers linear, adnate to the filaments, which are short; germ lanceolate-ovate, the angles (after the manner of T. sessile and the preceding) grooved; styles three. This is, hitherto, the largest species of the genus.

Uvularia *sessiliflora.*—*Hab.* Near Little Rock.

1. Smilacina *stellata.* 2. S. *racemosa.*

1. Polygonatum *multiflorum.* 2. P. *pubescens.*

LILIACEAE.

1. Lilium *superbum.* 2. L. *Philadelphicum.*

1. Erythronium *Americanum.* 2. E. *albidum,* Nuttall's Gen. Am. vol. 1, p. 223.—*Obs.* Leaves maculate; petals white, with a yellow spot at the base, externally bluish; stigma trifid, pubescent, reflected.

Scilla *esculenta* (Phalangium esculentum, Nuttall's Gen. Am. vol. 1, p. 219).—*Hab.* Common throughout the prairies of Arkansas and Red river.

1. Aletris *farinosa.* 2. A. *aurea.*

Agave *virginica.*

SPATHACEAE.

1. Allium *Canadense.* 2. A. *angulosum,* β **leucorhizum.* Scapo nudo teretiusculo; foliis linearibus, subtus convexis; umbella fastigiata;

filamentis subulatis.—*Hab.* On the margins of brooks, in the prairies of Red river.—*Obs.* The plant commonly twice the ordinary size of A. angulosum; the flowers also white, as well as the root, which in the other is covered with dark coloured reticulated sphacelous coatings; spatha in both 3-valved, and the cells of the capsule 1-seeded.

3. A. **ochroleucum*. Scapo nudo subtereti; foliis linearibus angustis rectis, subtus subconvexis; umbella pauciflora; corolla subcampanulata; filamentis subulatis.—*Hab.* In elevated prairies throughout the Arkansas territory.—*Obs.* Nearly allied to A. fragrans, the flowers also equally odorous, and the whole plant destitute of the characteristic alliaceous scent and taste; bulb covered with brown unreticulated sphacelous coatings, similar to that of a Scilla; scape four or five inches high; spathe 2-valved, obtuse; flowers from six to nine in the umbell, turbinate-campanulate, greenish white, and of a delicate fragrance; the filaments subulate and simple, not flat and linear as in A. fragrans; the leaves not half the breadth which they attain in that species, shorter than the scape, and a little convex beneath.

Yucca *recurvifolia?*—On the hills a few miles from Fort Smith.*

Pancratium *maritimum.*—Near Arkansas.

Crinum *Americanum.*—Throughout the Arkansas territory, in river marshes and wet prairies, often in great abundance, particularly near Red river.

Hypoxis *erecta.*—Near the Cadron settlement.

IRIDEAE.

Sisyrinchium *anceps.*—In the prairies this plant often occurs in extensive masses with the flowers of unusual magnitude.

1. Iris *versicolor*. 2. I. *hexagona*. 3. I. *cuprea?*

* In the Royal Botanic Garden at Paris, there was in 1814 a species of Yucca cultivated, called Y. Boscii, discovered by M. Bosc in Upper Carolina, and very nearly allied to Y. angustifolia of the Missouri, but distinguished by its subcarinately convex leaves, which were green and not glaucous, but they were equally narrow and filamentiferous.

NEMASTYLIS. Corolla hexapetala patens, tubo nullo; laciniis subaequalibus; stamina libera; stigmata sex, filiformia; capsula oblonga, truncata.—Radix bulbosa; folia ensiformia plicata; caulis uni aut pauciflorus; flores geminati; spatha bivalvis.

1. N. *coelestina* (Ixia coelestina, Bartram, it. 152, t. 3; Willd. Sp. pl. 1, p. 200). Caule unifloro, stigmatibus brevibus, seminibus angulatis.

Descript. Root a small and roundish tunicated bulb, covered with numerous dark brown sphacelous coats; radical leaves few, very long, ensiform and plaited, sheathing at the base; stem eighteen inches to two feet, partly terete, commonly producing a single leaf below the middle, and three or four other ones diminished to the size of sheathing bracts; the flowers (as far as I have seen) of a pale blue,† terminal and solitary; corolla superior, partly spreading, without tube; petaloid divisions oblong-obovate, nearly equal in size; stamina three; anthers linear; style one, short; stigmas three, filiform, bifid, white; capsule subclavate, oblong, obtusely 3-cornered, 3-celled, partitions medial; seeds numerous, angular and brown, a little smaller than those of the common onion. Flowering time from May to the close of June.—*Hab.* In the hilly prairies of the Arkansas territory, betwixt the sources of the Pottoe of Arkansas and the Kiamesha of Red river. First found in South Carolina by W. Bartram, whose figure appears to be very accurate.

2. N. **geminiflora.* Caule ramoso, ramis subtrifloris; stigmatibus longissimis; semina subrotunda.

Descript. Root a blackish tunicated bulb, covered with a great number of sphacelous coatings; scape about twelve inches high, nearly terete, 2-leaved, with one of them longer than the scape; radical leaves mostly three, equitant, ensiform and plaited, as in Tigridia, the central one double the length of the others (twelve to fourteen inches), the point attenuated, the colour light green, and with both surfaces nearly similar; branches of the scape mostly three, rarely two or four, subtri-

* From νῆμα a *thread*, and στύλος a *column* (or the style as employed in botany). This name is chosen by way of distinction from the structure of the same organ in Moraea.

† Those seen by my aged friend, William Bartram, in South Carolina, were of a bright azure blue, and of greater magnitude.

quetrous, 2-flowered; spathe 2-valved, 2-flowered, one of the peduncles and spathes above the other (within the conspicuous ovate spathes are one or two other filmy sheaths); corolla superior, partly pelviform, of six petals, and without a tube (about the size of a quarter dollar), of a bright azure blue, and white at the base, the divisions oblong-obovate, the three interior somewhat smaller; stamina three; anthers linear, yellow, rolling inwards after the opening of the flower, separate at the base, arising from the claws of the three larger divisions; stigmas six, filiform, alternating by pairs with the stamina, of a deep blue colour, and pubescent at the summits; capsule inferior, oblong, obtusely triquetrous, attenuated at the base, 3-celled, many-seeded; seeds subcylindric-obovate, obsoletely triquetrous, and attached horizontally in several rows.—*Hab.* The prairies, from near Fort Smith on the Arkansas to the banks of Red river; abundant. Flowering in May and June.

This genus, notwithstanding the artificial character, is more nearly related to Ixia than Moraea; it possesses nothing of that affinity to Iris, either in the inequality of the divisions of the corolla, or the petaloid nature of the stigma, with which the stamina also alternate. In natural aspect, the latter species of this genus approaches to Tigridia, but differs essentially in the uncombined stamens, and the approaching equality and conformity of the petaloid segments. The bulbs, the leaves, the stem, the general form of the flower, and that of the capsule, are nearly the same. The nearest affinity of this genus appears to be to Marica paludosa, from which it differs in the stigma and relative magnitude of the segments of the corolla.

COMMELINEAE.

1. Commelina *communis*. 2. C. *erecta*. 3. C. *angustifolia*.

1. Tradescantia *virginica*, and β *glabra*. Calicibus glabris, glaucescentibus. 2. T. *rosea*.

BROMELIAE.

Tillandsia *usneoides*. The first appearance of this plant, commonly called long-moss, along the banks of the Mississippi, is in the Cypress-bend, near the southern confines of the territory of Arkansas.

HYDROCHARIDEAE.

Vallisneria *spiralis* (V. Americana, Willd.).
Udora *Canadensis*.

*PONTEDEREAE.

Schollera *graminifolia*. In ponds near the banks of the Arkansas; rare.

Heteranthera *limosa*.

Pontederia *cordata*.—Rare.

Obs. These three genera, inseparable in natural affinity, appear to form a distinct section, better referable to this order than any other with which I am acquainted.

*ALISMOIDEAE.

1. Alisma *plantago*.

2. A. **rostrata*. Foliis cordatis obtusis; scapo subsimplici, paucifloro; capsulis ovatis, rostratis.—*Hab.* In the ponds of the Verdigris river of Arkansas. Flowering in June and July.—*Obs.* The plant much smaller than A. plantago, twelve to sixteen inches high; the scape triquetrous, frequently simple, or with at most two or three branches at the base, as in the inflorescence of Sagittaria; the leaves 5 to 7-nerved; peduncles three together, more than an inch in length; bracts linear; stamina about nine; rostrum of the fruit almost its length. Nearly allied, apparently, to A. cordifolia of South America.

1. Sagittaria *sagittifolia*. 2. S. *graminea*.—*Obs.* The leaves, as in most aquatics, variable in form and magnitude, in place of linear and gramineous often long and lanceolate, with as many as five nerves; The peduncles of the scape are all remarkably long and slender, and the capitulum of fruit smaller than usual.

3. S. **radicans*. Foliis cordato-ovatis, undulatis, obtusis; scapo angulato, prostrato, longissimo; floribus subverticillatis, verticillis radicantibus.—*Hab.* In ponds near Fort Smith. Flowering in June and July.—*Obs.* The plant rather large, with the petioles, scape and calix

slightly scabrous; leaves somewhat rigid, 7-nerved, four or five inches long and three or four wide; scape triangular, often growing out to the length of two or three feet, inclining downwards and sending out radicles and leaves at the verticills; verticills 6 to 9-flowered; bracts lanceolate-acuminate; calix striated, a little scabrous; peduncles rather long; flowers hermaphrodite; stamina about twenty; fruit subfalcate. This curious plant appears to be considerably allied to Alisma repens, of the south of Europe.

NYMPHAEACEAE.

NYMPHAEA *adorata.*

NUPHAR *advena.*

BRASENIA *peltata.*

All of these plants, so common within the limits of the tide water, are in this inland territory extremely rare.

CYAMUS *luteus* (Nelumbium luteum, Willd.).—The Osages and other western natives employ the roots of this plant, which is of common occurrence, for food, preparing them by boiling. In form, the tubers resemble those of the Batata (or sweet potato), and are traversed internally by from five to eight longitudinal cavities. They are found at the depth of twelve to eighteen inches beneath the surface of the earth, and are connected by means of running roots. The tubers arrive at maturity about the time that the seeds begin to ripen; before that period they abound with a milky juice, in common with the whole plant, and indeed with several other genera of aquatics, as Alisma and Sagittaria, allied to the Nymphaeaceae. When fully ripe, after a considerable boiling, they become as farinaceous, agreeable and wholesome a diet as the potato. This same species, which, according to the relation of Pallas, appears also to be indigenous to Persia, is every where made use of by the natives, who collect both the nuts and roots, as was practised with the κυαμος of Theophrastus* by the Hindoos and Chinese from the remotest antiquity.

* Cyamus Indicus.

SCITAMINEAE.

Canna *flaccida.*—On the banks of the Mississippi, a few miles below New Orleans.

Thalia *dealbata.*—In the ponds of the Pottoe river, and the Lesser North Branch of the Canadian; Arkansas; but not common.

ORCHIDEAE.

1. Orchis *psycodes.* 2. O. *spectabilis.* With the flowers mostly white, instead of particoloured.

3. O. **leucophoea.* Labello tripartito, laciniato, maximo; laciniis lateralibus internis obovatis crenulatis; cornu filiformi clavato, germine longiore.—*Hab.* In moist prairies near Kiamesha, Red river. Flowering in June.—*Obs.* Probably the largest species in the United States; the stem being from eighteen inches to two and a half feet high; leaves oblong-lanceolate, diminishing into narrow lanceolate bracts, about the length of the germ; flowers white, a little tinged with green; the lateral segments of the petaloid calix ovate, and less than half the length of the lip, which is divided into three dilated segments, divided nearly to the base into many capillary portions. It is more nearly allied to O. incisa than psycodes, but differs from the former in the laciniated lip, and from the latter by the multiplicity of its segments, and the obovate, instead of linear form of the two internal petaloid divisions.

4. O. **scutellata.* Labello subovali-oblongo, emarginato, basi utrinque ad medium dentato, cornu filiformi vix longitudine germinis; floribus sparsis; caule bifolio, foliis distantibus.

Descript. Root ; stem angular, about a foot high, bearing two distant, unequal, lanceolate, acute leaves, and two or three bracts below the commencement of the spike; floral bracts acute and sheathing, each about the length of the germ; flowers somewhat remote, forming a scattered spike three or four inches long; the three exterior or calicine segments obtuse and oblong, the two lateral, as usual, reflected; the two interior petaloid segments broader, more obtuse and connivent, a little crenulated along the margin in common with the lip, and both of a yellowish green colour; spur curving upwards, a little thicker towards the base, and scarcely the length of the germ; the lip somewhat longer than the lateral segments, partly oblong-oval, emarginate at the extremity, and at its commencement producing a denture on either side, and one protuberant or central elevation.—*Obs.* In this species the lip is much the broadest portion of the corolla, and the widest at its base, from which, as well as the two leaves upon the stem, and its uneven margin, it is readily distinguishable from O. tridentata, but approaches O. fuscescens, and cannot be O. clavellata of Michaux, which in several characters agrees nearly with O. tridentata. The name I have employed, is in reference to the form of the lip, which is very much like that of an armorial shield.—*Hab.* In grassy swamps, in the prairies near Fort Smith, and also throughout Pennsylvania and New Jersey, not uncommon.

TRIPHORA *pendula*, Gen. Am. vol. 2, p. 192 (Arethusa pendula, Willd. 4, p. 82).

CALOPOGON *pulchellum* (Cymbidium pulchellum, Willd.).

TIPULARIA *discolor*, Gen. Am. vol. 2, p. 195 (Orchis discolor, Ph. 2, p. 586).

MALAXIS (Microstylis) *ophioglossoides*, Gen. Am. vol. 2, p. 196.

CORALLORHIZA (Aplectrum) *hiemalis* (Cymbidium hiemale, Willd.).

CYPRIPEDIUM *pubescens*, Willd. Sp. vol. 4, p. 143.

ARISTOLOCHIAE.

1. ARISTOLOCHIA *tomentosa*. 2. A. *hastata*, Gen. Am. vol. 2, p. 200.

3. A. **reticulata*. Hirsuta; caule pumilo erecto; foliis subsessilibus, cordato-ovatis, obtusis, coriaceis, reticulatis; pedunculis radicalibus, racemosis, foliolosis; corolla labio retuso.—*Hab.* In woods, and on the shelvings of rocks on the banks of Arkansas and Red rivers; common. Flowering in June.—*Obs.* Root fibrous and aromatic, and entirely similar, in sensible qualities, to that of A. serpentaria. Stem scarcely a foot high, divided from the base, the upper part hirsutely pilose; leaves nearly sessile, roundish cordate or cordate-ovate, coriaceous and

partly sempervirent, the under surface conspicuously reticulated; peduncles radical, sometimes only 1-flowered, but more commonly several disposed in a leafy raceme; bracts oval; corolla pubescent, retorted, of a dark brown colour; the border trifid, the segments broad and retuse.

Asarum *Canadense.*

COTYLEDONES.

Cotyledons or germinal leaves generally two, dissimilar to the perfect foliage; in Pinus and Abies three to twelve.*

CONIFERAE.

1. Pinus *inops.* 2. P. *variabilis.* 3. P. *rigida.*

Juniperus *Virginiana.*

Cupressus *disticha, β imbricaria.—Obs.* Floriferous branchlets covered with imbricated scales; staminiferous flowers collected into turbinated aments; the scales numerous, dilated and adnate at the base; staminiferous column filiform; anthers ten to fifteen, excentrically peltate; fructiferous aments two or three together at the base of the branches, roundish, the scales also adnate at the base, with one or two germs under each, marked with a concave point.

POLYGONEAE.

1. Polygonum *aviculare.* 2. P. *erectum,* Lin.; Persoon, vol. 1, p. 439 (P. aviculare, β latifolium, Mich. Flor. Amer. vol. 1, p. 237; Nuttall's Gen. Am. vol. 1, p. 254). P. floribus pentandris trigynis axillaribus, foliis ovalibus obtusis, caule suberecto herbaceo.—*Obs.* A

* In Pinus there exist three stages of foliation; as first, the cotyledons, which are followed during the year of germination by single naked leaves, and afterwards by the adult leaves, collected from two to five together in common sheaths. The reverse of this takes place in most of the Acacias of New Holland, whose adult leaves are simple and imperfect, while the incipient foliage, or that which immediately succeeds the cotyledons, is compound, as in most other species of the genus.

very distinct species from P. aviculare, and a much larger plant.—Common to many parts of the United States in similar situations.

3. P. *tenue*, Mich. Flor. Am. vol. 1, p. 238; Ph. vol. 1, p. 270. 4. P. *hydropiperoides*. 5. P. *hirsutum*. 6. P. *Virginianum*. 7 P. *articulatum*. 8. P. *parvifolium* (P. polygamum, Vent.).—On the sand hills of Red river. 9. P. *convolvulus*.

1. Eriogonum **longifolium*. Caulescens; foliis oblongo-lanceolatis striatis subtus tomentosis, caulinis solitariis alternis; ramis floriferis fastigiatis corymbosis.—*Hab.* On the ledges of the Cadron rocks, and in denudated prairies from Arkansas to Red river.—*Obs.* Root partly fusiform, brownish red, astringent and bitter to the taste, in some measure resembling rhubarb; leaves cespitose, a span long, often slightly and superficially plaited, above villous and green, beneath white and tomentose; stem simple, bearing alternate and remote leaves, which diminish to a very small size towards the summit of the stem; flowering branches forming a compound corymb. Involucrum cyathiform, many-flowered; pedicells pilose; flowers whitish, externally tomentose and shining; stamens nine; styles three; germ lanuginous. A very distinct species, allied to E. tomentosum of Michaux.

2. E. **annuum*. Caulescens; foliis alternis oblongo-lanceolatis subtus tomentosis; ramis floriferis nudis cymosis; floribus glabris dioicis.—*Hab.* On the banks of the Great Salt river of Arkansas, and near the confluence of the Kiamesha and Red rivers.

Descript. Root brownish, perpendicular, sending out few fibres, and of annual duration (all the other species of the genus hitherto discovered are perennial); radical leaves crowded, distantly and irregularly crenulate, oblong lanceolate and acute, upper surface lanuginous, the under white and tomentose (after the manner of the genus); veins transverse and branching (in the preceding species longitudinal and parallel); stem terete and tomentose, often simple, sometimes considerably branched, the upper part naked, the lower often thickly set with leaves, destitute of nodes or swellings, as well as the preceding, the stature varying from one to three feet; cyme compound; involucres and flowers cyathiform; flowers of the clusters numerous, whitish, and, as in no other species, smooth and dioicous, extremely deciduous; segments of the petaloid calix unequal, the three larger in the styliferous flower obovate and emarginate, in the staminiferous oval and dilated, internally towards the base lanuginous; stamens nine; styles three; germ and seed smooth; radicle of the embryo incurved; this is by far the most extraordinary species of the genus, and in the flowers somewhat allied to E. parviflorum.

1. Rumex *verticillatus.* 2. R. *persicarioides.* 3. R. *acetosella.*—*Hab.* On the hills of Masard prairie, six miles from Fort Smith, indubitably native.

Brunnichia *cirrhosa.*—On the overflowed banks of the Arkansas; common.

CHENOPODEAE.

1. Chenopodium *hybridum.*—At the confluence of Verdigris and Arkansas rivers. 2. C. *ambrosioides.*

Atriplex *hortensis.*—Introduced.

Kochia *dentata.*—Common on all the sand beaches of the Arkansas, and remarkable by its almost innumerable branches.

Corispernum **Americanum* (C. hyssopifolium, Ph. Nutt. Gen. Am.).—In similar situations with Kochia; common.†

AMARANTHEAE.

1. Amaranthus *albus.* 2. A. *hybridus.*

3. A. **tamariscinus.* Racemis supradecompositis nudis erectis glabris, foliis lanceolatis.—*Hab.* On the sand beaches of the Arkansas and Grand rivers; abundant; possessing, in some respect, the aspect of A. *albus.*—*Obs.* Stem three or four feet high and much branched, and as well as every other part of the plant perfectly smooth; flowering branches very compound and destitute of leaves, so as almost to resemble branches of Tamarix gallicus, the bracts being green, minute, imbricated and spinulose.

Alternanthera *repens*, Elliott.—On the banks of the Mississippi, and in the streets of New Orleans.—*Obs.* Heads of flowers roundish-ovate, sessile; bracts three; calix rigid, 5-parted, two or three of the

† Camphorosma ought to be excluded from the American Flora, having been inserted without sufficient authority.

segments smaller, externally pubescent towards the base, the pubescence consisting of barbed and numerously articulated hairs; stamina united into a small cup at the base, the filaments ten, of which five are without anthers; anthers 1-celled; stigma very short, partly capitate and undivided; utriculus, 1-seeded.

ACHYRANTHES **lanuginosa.* Caulibus prostratis diffusis, floribus sparsis cum foliolis congestis lanuginosis obvallatis, foliis subrotundo-ovatis.—*Hab.* On the sand-beaches of Great Salt river, Arkansas. Flowering in September.—*Obs.* Annual and every where densely lanuginous, the pubescence consisting of verticillately ramified hairs; leaves alternate, petiolate, roundish-ovate, obtuse and attenuated at the base; those of the branchlets crowded and sessile, amidst which are situated the scattered flowers, each mostly subtended by three small bracts; calix rigid, 5-parted, the segments somewhat linear and unequal, pubescent at the summits; stamina five, united into a small cup at the base; intercalary filaments none; anthers 1-celled; stigma capitate, undivided; utriculus 1-seeded, not valvular. A much larger species than the preceding, often spreading over a circumference of five or six feet. Possessing a good deal the habit of Illecebrum frutescens.

IRESINE *celosioides.*—On the alluvial banks of the Arkansas.—*Obs.* Perennial. Flowers dioicous, collected into paniculated spikes; calix 5-parted, membranaceous, subtended by three paleaceous bracts; corolla none, nor any petaloid process; stamens five, all fertile; anthers 2-celled; calix of the fruit-bearing flower only, subtended by long copious woolly hairs; stile one; stigmas two, filiform; fruit a 1-seeded membranaceous utriculus; the seed dark brown, containing an incurved embryo. This description, which so materially differs from that of others, proves an essential affinity to the genus Amaranthus, from which it merely differs in the utriculus, which bursts irregularly, and in the singular wool, which subtends the base of the female calix.

PARONYCHIA *dichotoma,* Gen. Am. vol. 2, p. 159 (Illecebrum dichotomum, Willd.).—On the denudated prairies of the Arkansas and Red rivers.

1. ANYCHIA *dichotoma.* 2. A. *capillacea,* Gen. Am. vol. 2, p. 159. Perfectly distinct from the preceding, whose place it wholly occupies in the northern states.

OPLOTHECA *floridana,* Gen. Am. vol. 2, p. 78, 79.—*Obs.* Root annual; stem branched from the base; leaves thick and somewhat succulent, no way scabrous in a living state. Flowers spirally imbricated, in five ? rows.

PHYTOLACCA *decandra.*

RIVINA **portulaccoides.* Racemis simplicibus; floribus tetrandris; foliis ovatis subundulatis acuminatis glabris; caule sulcato herbaceo; baccis siccis.—*Hab.* On the alluvial lands of the Verdigris river, near its confluence with the Arkansas.—*Obs.* Plant smooth, three or four feet high; racemes many-flowered, erect, axillary and terminal; calix rosaceous, becoming green in the fruit; utriculus greenish and juiceless; seed lunate, on one side convex. Nearly allied to R. laevis.

SANTALACEAE.

COMANDRA *umbellata,* Gen. Am. vol. 1, p. 157 (Thesium umbellatum, Lin.).

HAMILTONIA *oleifera,* Willd. (Pyrularia, Mich.).

1. NYSSA *biflora.* 2. N. *candicans.*

THYMELEAE.

DIRCA *palustris.*—In the alluvial lands of the Pecannery settlement.

LAURINEAE.

1. LAURUS *sassafras* and β *albida.* 2. L. *benzoin.*

AMENTACEAE.

1. SALIX *conifera.* 2. S. *nigra.* 3. S. *longifolia.*

1. POPULUS *monilifera.*—Abundant in the inundated banks of the Arkansas and Red river. The bark always appears whiter and smoother than in the following, and the branches are not angular; in other respects they are precisely alike. 2. P. *angulata.*

MYRICA *cerifera.*—*Hab.* On the pine cliffs contiguous to the Arkansas.

Betula *populifolia.*—On the banks of Grand river of the Arkansas; rare.

Carpinus *Americana.*

Ostrya *virginica.*—Banks of the Arkansas.

Fagus *sylvatica.*—Not met with to the south of the river St Francis.

1. Castanea *pumila.*—Chiefly on the summits of hills and mountains. 2. C. *nana*, foliis oblongis, acutis, mucronato-serratis, glabris; nucibus solitariis.—*Hab.* On the pine-hills of the Arkansas; a shrubby species, allied to C. pumila (C. nana, Muhl. Catal. et Herb.). The younger leaves are sometimes slightly pubescent. This species also grows abundantly around Tallahassee, in West Florida. It is always more dwarf than C. pumila.

1. Quercus *phellos.* 2. Q. *imbricaria.* 3. Q. *aquatica.* 4. Q. *nigra.* 5. Q. *tinctoria.* 6. Q. *coccinea.* 7. Q. *rubra.* 8. Q. *falcata.* 9. Q. *obtusiloba.* 10. Q. *macrocarpa.* 11. Q. *lyrata.* 12. Q. *alba.* 13. Q. *bicolor.* 14. Q. *montana.* 15. Q. *castanea.* 16. Q. *chinquapin.*—On the hills contiguous to the Great Salt river, and on the summits of the mountains of the Pottoe.

Corylus *Americana.*—On the banks of the Salaiseau and Spadrie creeks of the Arkansas; rare.

Liquidambar *styraciflua.*—*Obs.* Masculine ament conic, each flower polyandrous; proper calix 5-leaved, the exterior leaflets larger. In this country, as in South Carolina, it affords storax by incision.

Platanus *occidentalis.* In this country it is not large, and appears to be on the verge of its southern limit.

1. Juglans *nigra.* 2. J. *cinerea.*

1. Carya (Gen. Am. vol. 2, p. 220) *olivaeformis.* 2. C. *alba.* 3. C. *tomentosa.* 4. C. *amara.* 5. C. *porcina.* 6. C. *aquatica.*

1. Fraxinus *quadrangulata.* 2. F. *Caroliniana.* 3. F. *sambucifolia.*—*Obs.* Leaves and petioles before expansion covered with glandular scales, emitting the odour of the walnut; branches glabrous, the bark of the trunk reticulately rimose.

URTICAE.

1. Urtica *urens.* 2. U. *procera.*—This species often attains the height of eight or ten feet.

3. U. **purpurascens.* Pumila, hirsuta; foliis oppositis cordato-ovatis dentatis longe petiolatis; floribus monoicis glomeratis subsessilibus.—*Hab.* In the shady alluvial and overflown forests of the Mississippi and Arkansas. Flowering in February.—*Obs.* Perennial and urent. Stem quadrangular, six to ten inches high, grooved, purple and hispid; petiole of the lower leaves as long as the lamina (one inch); leaf hispid, roundish-cordate, dentate, on the lower part of the stem obtuse, higher up acute, partly 5-nerved, beneath commonly purple; stipules linear, reflected; flowers axillary, in shortly pedunculated conglomerate clusters, shorter than the petiole, and coming out by pairs; stamens four, elastic; gland depressed; female calix 2-leaved; seed elliptic, compressed. 4. U. *Canadensis.*

Boehmeria *cylindrica.*

Parietaria *Pennsylvanica.*

Celtis **integrifolia.* Foliis oblique ovatis acuminatis integris membranaceis glabriusculis, pedunculis adnatis subbifloris.—*Hab.* On the banks of the Mississippi, White, Red and Arkansas rivers, &c. forming a tree of moderate magnitude, with the bark even or rimose; branches flexuous; leaves smaller than usual; stipules oblong and membranaceous, caducous; flowers dioicous, often ternate, with two of the pedicells frequently conjoined; stamina mostly five, rarely six; berries solitary, fulvous brown, and of a saccharine taste. Flowering in March. C. occidentalis, β integrifolia, Gen. Am. vol. 2, p. 202.

1. Ulmus *Americana.*

2. U. **crassifolia.* Foliis parvulis confertis oblongo-ovatis obtusis serratis, basi inaequalibus; ramis teretibus.—*Hab.* On the prairies of Red river. A species bearing some resemblance to U. alata, but much more nearly related to U. pumila of Siberia.—*Obs.* A tree of moderate magnitude, crowded with small, thick and opaque scabrous leaves and intricate spreading branches, affording a dense shade, and of a very deep verdure. The leaves are moreover somewhat pubescent beneath, scarcely an inch long, and about five lines wide, with the margin for the most part simply serrated and the serratures obtuse. The flowers and fruit I have never seen.

1. Morus *rubra.* 2. M. *scabra.*

Maclura *aurantiaca.*—*Hab.* In two or three localities on the banks of the Arkansas, as, near the Cadron settlement, and on the banks of the Pottoe, a few miles from Fort Smith; but only abundant on the banks of Red river and the Washita.—*Obs.* Not being acquainted with the stameniferous flowers of this genus when I published it in the Genera of North American Plants, vol. 2, p. 233, I shall now add a description of them, so as to complete the character. The male flowers, which I obtained near the confluence of Red river and the Kiamesha, in a withered and persistent state, appeared to have been in flower early in the month of May. They are quite small, and of a greenish colour, collected into roundish, clustered and pedunculated racemes, after the manner of beech flowers of the same sex, each being furnished with a proper filiform peduncle. The calix, as in Morus, is 4-parted, with oblong segments, and not more conspicuous or larger than the ordinary flower of a nettle; the stamens are commonly four in number, sometimes less; the filaments, which are pubescent at the base, appear longer than the calix, and by their structure, in all probability, spring forward elastically after the opening of the flower, as is common with Urtica and some neighbouring genera. The 2-celled anthers, as well as the filaments, are also persistent.

The wood of this tree appears almost precisely similar to that of the Fustick (Morus tinctoria) of commerce, but does not afford a permanent dye. From the true Fustick this plant is perfectly distinct; its fruit is vastly larger, and not, as in that, composed of *distinct acini*, but of germs which naturally ingraft themselves into a simple many-seeded berry like the orange, &c.

Humulus *lupulus.*

EUPHORBIACEAE.

1. Euphorbia *cyathophora.*—Near Fort Smith. This species, in the United States, is always herbaceous and annual. In the West Indies it appears to be shrubby. 2. E. *graminifolia.*—Agreeing with Michaux's description, except in being perfectly smooth, and apparently not much inclined to branch.

3. E. *dentata*, Mich. Hirsuta, erecta; foliis oppositis alternisve, ovato-lanceolatis dentatis concoloribus; floribus ad summitates congestis.

—*Hab.* Banks of the Arkansas.—*Obs.* Stem hirsute and branching from the base; upper surface of the leaves smooth; dentures often uncinate; calicine glands green and cup-shaped; angles of the fruit obtuse.

4. E. *hypericifolia.* 5. E. *thymifolia* (E. maculata, Jacquin. Hort. Vind. t. 186, β *disticha). Foliis distichis approximatis; caule suberecto.—*Hab.* Banks of the Mississippi and Arkansas.

6. E. **herniaroides.* Humifusa prostrata glaberrima; foliis oppositis subrotundo-ovalibus integerrimis; floribus sparsis plerumque aggregatis, coccus carinatus.—*Hab.* On the overflowed banks of the Arkansas and Mississippi. Nearly allied to E. microphylla of India.—*Obs.* Annual. Stem prostrate, diffusely branched, sometimes repent towards the base; leaves roundish-oval, about the size of those of thyme; stipules partly ovate, membranaceous; flowers approximating, axillary and terminal, greenish and inconspicuous.

7. E. **maritima.* Parvula, glabra; foliis oppositis integerrimis lineari-oblongis brevibus; floribus sparsis dichotomalibus subsessilibus, fructibus subrotundis; caule procumbente.—*Hab.* On the sea beach of New Jersey.—*Obs.* Annual. The plant small, diffusely and dichotomously branched, the branches not flaccid; stipules setaceous; flowers green and inconspicuous, approximating towards the summits of the branchlets; styles very short; the fruit smooth and roundish, with the angles almost obsolete, and more than twice the size of that of E. thymifolia, though the plant is of nearly the same magnitude, and perfectly smooth.—This species appears to be somewhat allied to E. polygonifolia, and I have introduced it here in consequence of its affinity to the following.

8. E. **arenaria.* Glabra, foliis oppositis integerrimis linearibus oblongiusculis obtusis remotis; pedunculis dichotomalibus solitariis; corolla alba tetrapetala.—*Hab.* On the sandy banks of the Arkansas and Red rivers.—*Obs.* Annual. Stem diffusely branched, somewhat glaucous; leaves about an inch long; petals white and conspicuous, as in E. corollata; fruit roundish, the angles obtuse. Flowering in June and July.

9. E. **heterantha.* Caule erecto angulato, opposite ramoso; foliis oppositis lineari-lanceolatis acutis integerrimis; floribus sparsis dichoto-

malibus luteis monoicis.—*Hab.* On the sandy banks of the Arkansas, from Fort Smith to Salt river. Flowering in July.—*Obs.* Annual. Stem erect and much branched, one to two feet high; leaves thin, all of the same colour, two to two and a half inches long, and about half an inch wide in a younger state, on the under side as well as the unexpanded flowers slightly pubescent, those of the branchlets very narrow and linear; flowers dichotomal and sometimes partly axillar; calicine involucrum cyathiform, the border merely 5-cleft, the segments subovate and acute, above yellow, each bearing a cup-shaped gland at its base; very few of the flowers fructiferous; stamens, as in the rest of the genus, articulated, perfecting at different times; fruit smooth and distinctly 3-lobed. The flowers differ materially from those of any other of the North American species.

10. E. **peploides.* Umbella subtrifida dichotoma, involucellis reniformi-cordatis; foliis integerrimis cuneato-obovatis subconfertis erectis; laciniis petaloideis bicornibus.—*Hab.* From the town of Arkansas to the garrison of Fort Smith, in denudated soils. Flowering in April.—*Obs.* Annual. Stem about a span high, simple or branched towards the summit; leaves smooth, thickly scattered, erect, sometimes subimbricate, sessile, cuneate and partly retuse, the upper ones largest; umbell 3 or 4-cleft; proper involucrum suboval; leaves of the involucell cordate-reniform and obtuse; flowers dichotomal, small and yellowish; segments of the involucrum four and five, crescent shaped, with the extremities subulate; capsule 3-lobed, smooth and even. Nearly allied to E. peplus.

11. E. *obtusata*, Ph. Flor. Am. Sept. 2, p. 606.—Very nearly allied to the preceding. 12. E. *marginata.*—*Hab.* On the banks of the Arkansas from the Verdigris to Salt river.—*Obs.* Stamina numerous, intermingled with infertile pubescent filaments. 13. E. *corollata.*

Acalypha *virginica.*—*Obs.* Male flowers minute, disposed in a conglomerated pedunculate spike, arising from the base of the feminine involucrum; calix 4-parted; corolla none; stamina four to eight?, minute. Feminine flowers three or more together; calix 3-parted; corolla none; capsule tricoccous, hirsute; stigmas three, multifid (four, five or more cleft).

Tragia **angustifolia.* Hirsuta, caule erecto ramoso; foliis inferioribus subovatis petiolatis acute dentatis, superioribus lineari-oblongis sessilibus; pedicellis bracteis longioribus.—*Hab.* On the prairies of Red river, in arid situations.—*Obs.* Perennial. Stem five or six inches high, somewhat branched, and, as well as the other parts of the plant, slightly hirsute and stinging; stipules subulate and minute; flowers often tetrandrous, with a 4-cleft calix; capsule hispid. Nearly allied to T. urens, but the leaves are every where equally toothed, and the plant perennial.

2. T. **betonicaefolia.* Hirsuta, caule erecto subsimplici; foliis cordato-ovatis petiolatis, acute dentatis; pedicellis bracteis brevioribus.—*Hab.* With the preceding, to which it is nearly related, and also to T. urticaefolia. This species I have also collected in East Tennessee, and like the former it is perennial. From the figure of T. nepetaefolia, given by Cavanilles, I should have concluded it to be the same plant, only that it is described as an annual, much branched, and with the leaves glaucous beneath, in all which particulars it differs from our plant.

1. Croton *glandulosum.* 2. C. *capitatum.* 3. C. *ellipticum* (Crotonopsis elliptica, Willd.).

4. C. **muricatum.* Caule herbaceo ramosissimo; foliis oblongo-lanceolatis integerrimis tomentosis; floribus dioicis, masculis subpaniculatis glomeratis; stigmata multifida; capsula muricata.—*Hab.* On the sand beaches of Great Salt river, Arkansas. Flowering in September.—*Obs.* Annual. The whole plant covered with a whitish stellate pubescence. Stem much branched, about two feet high; leaves alternate and opposite, petiolate, those of the female plant narrower and green on the upper surface; branches of the staminiferous plant terminating in naked paniculated clusters of flowers, consisting merely of a roundish calix, each containing about ten or twelve uncombined stamens. Female, mostly solitary, dichotomal and terminal; the calix 5-cleft, and divided nearly to its base, with the segments acute; corolla none; styles three, stigmas about eighteen! capsule subglobose, tricoceous, tomentose and muricate, with soft protuberances. The whole plant, as in most of the genus, aromatic.

Crotonopsis *linearis*, Mich. (Croton?).

*Aphora†. Polygama. *Mas.* Calix quinquepartitus; petala quinque; filamentum columnare; stamina septem, duo interiora; rudimenta quinque, minuta. *Fem.* Calix major; petala nulla; filamenta quinque, infertilia; stigmata tria, bifida; capsula tricocca, trisperma.

Herba perennis, non lactescens, odore foetida, caule simplici; folia integra exstipulata, alterna; flores racemosi, axillares, bracteolati. Ditaxis affine, sed habitu diversa.

A. *mercurialina.* Caule subsimplici; foliis obtusis pubescentibus; petalis integris.

Descript. Root perennial. The whole plant thinly covered with undivided appressed hairs; stem simple, grooved, from twelve to fifteen inches high; leaves oblong-ovate, entire and obtuse, partly 3-nerved, alternate, sessile and rather numerous, from ten to fifteen lines long and about five lines wide; racemes pedunculate, solitary and axillary, much longer than the leaves; the flowers, which are greenish, subtended by minute bracts, the staminiferous ones much more numerous than the others, and sustained by shorter pedicells. Some of the plants produce only male flowers, others female or an admixture of both. *Male* calix 5-parted, the segments linear-lanceolate, acute and erect; petals oblong, also greenish; filaments united into a column; anthers in two sets, two and sometimes three above the other five, 2-celled. The rudiments of five other filaments appear round the base of the antheriferous column. *Female* calix producing lanceolate and acute spreading segments, divided to the base, and at least three times larger than those of the male flower; corolla none; infertile filaments five, conspicuous; style very short; stigmas three, short and reflected, partly bifid; capsule tricoccous, pubescent, cells 1-seeded. I have not been able to trace the affinities of this curious plant, which in some respect resembles Mercurialis annua. It bears no affinity to Croton, its pubescence is simple and its odour fetid; Ditaxis, to which it is closely allied, is an arborescent dioicous plant.—*Hab.* In hilly and denudated portions of the calcareous prairies of Red river, near the confluence of the Kiamesha. Flowering in the latter part of May and June.—*Obs.*

† From ἀφορία sterility, in allusion to the infertile filaments existing in the flowers of both sexes.

The Croton lanceolatum, Cavan. ic. 6, p. 38, t. 557, f. 2, appears to be a second species of this genus, but produces only five? stamens and five glands exterior to the germ and stamina, in place of filaments; but this species ought perhaps to be re-examined in a living state, as the flowers are minute.

*MASCHALANTHUS.† Monoica. Calix sexpartitus; stamina monadelpha, tria; torus glandulosus, sex ad duodecim-dentatus; styli tres; capsula trilocularis; loculis dispermis.

1. M. *obovatus* (Phyllanthus Carolinianus, Mich. Fl. Am. vol. 2, p. 209). Annuus. Foliis obovatis obtusiusculis; floribus subgeminis axillaribus sessilibus; caule erecto ramoso tereti.

2. M. **polygonoides*. Suffruticosus, humilis; foliis cuneato-oblongis acutiusculis, stipulis membranaceis subulatis; floribus axillaribus pedunculatis subquinatis.—*Hab.* On calcareous rocks in the plains of Red river. Flowering in May and June.—*Obs.* Root woody; stem very short (four to six inches), sending out numerous branches from the base, which towards the root are crowded with sphacelous stipules; branches filiform, terete and decumbent; pedicells capillary. Masculine calix minute, the segments membranaceous on the margins; stamina three, monadelphous; glandular disk 6-toothed?; petals none. Female flowers mixed with those which are staminiferous, or occasionally on a distinct plant; the calix larger and foliaceous; petals none. The whole aspect and magnitude of the plant is similar to that of Polygonum aviculare. To this genus ought probably to be referred several other species included in Phyllanthus.

*LEPIDANTHUS.‡ Dioica. Calix quinquepartitus; petala quinque; stamina quinque, libera; torus glandulosus, decemdentatus; styli tres, bifidi; capsula trilocularis; loculis dispermis.

Frutex humilis; folia alterna integra, stipulis minutis; flores axillares.

L. *phyllanthoides*. *Descript.* Shrub much branched, two to three feet high; branches ferruginous and brittle; branchlets striate, a little

† From μασχάλη axilla, and ανθος a flower, the flowers being strictly axillary, and not produced upon foliaceous expansions of the stem.

‡ From λεπις a scale or petal, and ανθος a flower; in allusion to the existence of petals in this genus which are wanting in Phyllanthus.

hairy; leaves roundish-oval, entire, very obtuse, subsessile and reticulately veined; stipules minute, ferruginous, pilose and acute; peduncles filiform; the male flowers growing commonly by three together; the female ones single. *Male* calix 5-parted; segments oblong, obtuse, and with the margin pubescent; petals five, alternate, yellowish-green, cuneate-oblong, obtuse; glandular ring or torus 10-toothed; stamina five, unconnected; styles three, abortive; stigmas undivided. *Female* calix almost exceeding the fruit in magnitude, 5-parted, the divisions roundish-oval, green and foliaceous; petals five, minute, almost like glandular appendages; styles three, bifid; capsule round and somewhat succulent, 3-celled, cells 2-seeded; seeds triquetrous, not elastically arillate?

This plant is nearly allied to Phyllanthus, and more particularly to the North American section of that genus. The leaves possess in a weaker degree the aroma and flavour of tea.—*Hab.* In the torrents of the Mazern mountains, towards the sources of the Pottoe and Kiamesha, as far as the vicinity of Red river; abundant. Flowering in May and June.

Jatropha *stimulosa*, Mich.—In the upland forests of Red river.

Stillingia *lanceolata. Herbacea; foliis subsessilibus, ovato-lanceolatis acutis, serratis.—*Hab.* In the prairies at Belle Point, Fort Smith. Nearly allied to S. sylvatica.—*Obs.* Spike about three inches long; the flowers yellowish and diandrous; cells of the anthers remote, only partially opening along the margin.

Forestiera, Poiret, Encyc. suppl. 2, p. 664 (Adelia, Mich. Fl. Bor. Am. t. 48; Borya, Willd. Sp. pl. 4, p. 711; Pursh, 1, p. 22; Bigelovia, Smith, Encyc. Lond. Suppl.).

Dioica. *Mas.* Involucrum tetraphyllum, multiflorum; calix 0; corolla 0; stamina 4—6, decidua, pedicello nudo insidentia iis articulata, diverso tempore erumpentia. *Fem.* Stigma capitatum; drupa monosperma obliqua.

F. *acuminata.*—*Obs.* A large shrub, sometimes bordering upon a tree, and sending out many stems from the same root. Branches not unfrequently terminating in spines. Male flowers irregularly scattered over the branches in sessile buds, which appear before the developement of the leaves; they are destitute of a proper calix and corolla. The involucrum consists of nothing more than the four innermost greenish decussated bud scales, the lower ones being smaller, sphacelous and more numerous. The flowers are aggregated by six, eight, or more together, and the stamina, four to six in number, are articulated to a common receptacular pedicell, and exserted beyond the involucrum, perfecting at different times; anthers roundish, adnate to the filaments. The singular structure of the flowers, notwithstanding the disparity of the fruit, renders this plant inseparable from the order of Euphorbia.—*Hab.* In the inundated lands of the Ohio, Mississippi, Arkansas and Red rivers.

2. F. **pubescens.* Foliis ovatis serrulatis pubescentibus subpetiolatis; fructibus oblongis parvulis.—*Hab.* In the prairies of Red river. —*Obs.* A low and very much branched shrub, almost similar to a sloe bush; branchlets and leaves pubescent; leaves obtuse or acute, opposite; fruit cylindric-oblong, black and saccharine to the taste, upon longish peduncles, and scarcely half as large as that of F. acuminata, the nut striated and a little oblique, the shell flexible; embryo flat and erect, immersed in the centre of a cartilaginous albumen. As this plant is now cultivated in the gardens of Messrs Landreth and Bartram, I imagine it to be the same which Mr Pursh saw among the specimens collected by Lyons, which I can by no means reconcile to the description of F. ligustrina of Michaux.

PLANTAGINEAE.

1. Plantago *major.* 2. P. *virginica.*

3. P. **purpurascens.* Foliis lanceolatis dentatis pubescentibus; spica laxiuscula; stamina exserta; scapo tereti hirsuto.—*Hab.* On the banks of the Arkansas; abundant. Nearly allied to P. virginica, but with the stamens always exserted, and the leaves often retrorsely toothed.—*Obs.* Biennial. Almost canescently pubescent; anthers purple.

4. P. **heterophylla.* Foliis linearibus sublaciniatis planis, basi lanatis; scapo tereti.—*Hab.* On the banks of the Mississippi and Arkansas; frequent. Allied to P. maritima, but not succulent, the plant much

smaller, with the leaves sometimes almost filiform, and the scape pubescent.

5. P. *pusilla*, Gen. Am. vol. 1, p. 100 (P. aristata, Mich. Fl. Am. 1, p. 95). 6. P. *gnaphaloides*, Gen. Am. vol. 1, p. 100 (P. lagopus, Ph. Fl. Am. 1, p. 99).

7. P. **squarrosa*. Stamina inclusa; foliis linearibus striatis glabris; scapo tereti lanuginoso; bracteis linearibus longissimis.—*Hab.* In arid and denudated places in the prairies near Belle Point or Fort Smith.—*Obs.* Annual. Leaves four or five inches long, two or three lines broad, smooth, shining and arid, attenuated at the base, membranaceously sheathing; caudex woolly; bracts from half to three quarters of an inch long, nearly smooth and filiform; calix woolly, segments obtuse; capsule 2-seeded. Allied to P. gnaphaloides.

NYCTAGINEAE.

1. Calymenia *corymbosa* (Mirabilis corymbosa, Cavan. ic. 4, p. 55, t. 379; Allionia nyctaginea, Mich. Fl. Am. 1, p. 100; Ph. Flor. Am. 1, p. 97; Calymenia nyctaginea, Gen. Am. vol. 1, p. 25).

2. C. *angustifolia*, Gen. Am. vol. 1, p. 26.

PRIMULACEAE.

Androsace *occidentalis*.—*Hab.* On the rocky summit of a hill in Cedar prairie, ten miles from the garrison.

Dodecatheon *integrifolium*, *β *album*. Foliis ovatis, integriusculis, umbellis paucifloris; bracteis lanceolatis acutis; floribus albidis.—*Hab.* In humid prairies near Fort Smith. Flowering in April and May.—*Obs.* Leaves ovate or lanceolate, sometimes subdenticulate, four or five inches long; segments of the calix and bracts very acute, the latter sometimes acuminated; flowers constantly white, segments elliptic-oblong or oblong-lanceolate, spotted towards the base; incrassated filaments, sometimes purple.

Lysimachia *ciliata*.

Anagallis *arvensis*. Introduced.

Micranthemum *orbiculatum*.

Centunculus *lanceolatus*.—On the margins of ponds near Fort Smith.

Samolus *Valerandi.*—Near the town of Arkansas.

Utricularia *vulgaris.*

SCROPHULARINEAE.

Pedicularis *Canadensis.*—The flower is here always ochroleucous.

Melampyrum *lineare* (M. Americanum, Mich.).

Scrophularia *Marilandica.*

Antirrhinum *Canadense.*

Veronica *peregrina*, Willd. Sp. Pl. 1, p. 76; Vahl. Enum. pl. 1, p. 85.—Common.

Leptandra *virginica*, Nutt. Gen. Am. vol. 1, p. 7 (Veronica virginica, Lin.; Callystachya, Rafinesque. A name heretofore employed for another genus).

Collinsia **violacea.* Puberula, foliis ovato-lanceolatis, remote denticulatis; corolla subconcolore; labio superiore inferiore dimidio minore, laciniis omnibus apice bifidis; capsulis subdecemspermis.—*Hab.* On the hills and upland woods of the Arkansas and Red rivers; abundant. Flowering in April and May.

Descript. Annual. Root fibrous; stem terete, oppositely branched, pulverulently pubescent, mostly purple, and from four to twelve inches high; radical leaves oblong-ovate, those of the stem ovate-lanceolate, sessile, opposite, remotely denticulate and acute, of a somewhat thickish consistence and covered with a pubescence similar to that of the stem, the uppermost verticillate in threes; calix subcampanulate, 5-cleft, the base angular, segments ovate-lanceolate acute; corolla bright violet (like that of many species of the genus Phlox), the upper lip paler; segments bifid at the extremity, those of the lower lip partly obcordate, segments of the upper somewhat truncate, and about half the size of the lower; the palate of the upper lip marked with a reniform, yellowish and fulvous spot, which is immaculate in the centre; stamina four, declinate, the rudiment of a fifth at the base of the tube of the corolla; filaments pubescent towards the base; style simple, filiform; stigma minute; capsule roundish-ovate, partly 2-celled, imperfectly 4-valved; germ about 10-seeded? seeds much smaller than in C. verna. Allied to C. grandiflora of Oregon.

MIMULUS *alatus*, Willd. Sp. Pl. 3, p. 361; Ph. Fl. Am. 2, p. 426.

1. GERARDIA *purpurea*. 2. G. *tenuifolia* and β **parviflora*. Floribus minoribus; calice tubo corollae aequali, dentibus acuminatis; fructibus majoribus.—*Hab.* In the prairies of the Arkansas above the Verdigris river. Apparently a distinct species.—*Obs.* Annual. The stem is less branched, and inclined to grow taller than G. tenuifolia, whose flowers are larger, with a much smaller calix.

3. G. **longifolia*. Caule subsimplici; foliis filiformibus scabris, pedunculo elongato longioribus; floribus maximis; calicis dentibus longe acuminatis.—*Hab.* On the banks of the Arkansas. Flowering in August and September.—*Obs.* At first sight this species might be confounded with G. purpurea, although perfectly distinct, and apparently intermediate with it and G. tenuifolia. Annual. Stem twelve to eighteen inches, quadrangular; leaves opposite, from one and a half to two inches in length, and not broader than those of the Weymouth pine; the peduncles a little shorter, opposite and axillary; calix campanulate, its acuminate segments nearly its length; corolla somewhat larger than that of G. purpurea, purple, with the margins of the lobes pubescent.

4. G. **heterophylla*. Foliis scabris lineari-lanceolatis acutissimis, inferioribus sublaciniatis trifidis; floribus subsessilibus; calicinis laciniis linearibus acuminatis patentibus.—*Hab.* In the prairies of the Arkansas, near Great Salt river. Flowering in September.—*Obs.* Annual. Stem angular, about two feet high, and much branched; leaves opposite and alternate, the lower ones trifid or laciniate; the flowers approximating towards the summits of the branches, purple, with the segments pubescent along the margin; segments of the calix linear and very acute, as long as the undivided base, and falcate or spreading.

5. G. *auriculata*, Mich. Flor. Am. 2, p. 20. 6. G. *quercifolia*, Pursh, 2, p. 423. 7. G. *pedicularia*.

SEYMERIA *macrophylla*, Gen. Am. vol. 2, p. 49.—On the banks of the Arkansas near the garrison.

EUCHROMA *coccinea*, Gen. Am. vol. 2, p. 55 (Bartsia coccinea, Lin.).

2. E. **purpurea*. Foliis cuneatis trifidis sublaciniatis, bracteis rubris consimilibus; calix corollisque coloratis quadrifidis, unilateralis; corolla laciniis acutis.—*Hab.* On rocks in the hilly prairies of Red

river. Flowering in May.—*Obs.* Perennial. Stem tomentose, the leaves more slightly so; bracts, calix and corolla of a brilliant reddish purple; segments of the calix linear, all inclined to one side, and nearly the length of the corolla; apex of the upper lip of the corolla greenish (no glands at the base of the lower lip); seed covered with a reticulated and perforated membranaceous vesicle. Considerably related to *E. grandiflora*, but differing in the proportions of the flower, and the dilation and brilliant colour of the bracts.

1. HERPESTIS *rotundifolia.* 2. H. *Brownei.*—Banks of the Mississippi.

1. GRATIOLA *virginica.* 2. G. *pilosa.* 3. G. *anagallidea*, Mich. (G. acuminata, Elliott, Sketch Bot. Carol. 1, p. 15, not of Pursh).

1. LINDERNIA *pyxidaria* (L. dilatata, Muhl. Catal.; Elliott, Bot. Carol. 1, p. 16). 2. L. *attenuata*, Muhl. Catal.—*Obs.* The capsule in this genus appears to be generally 1-celled.

CHELONE *glabra.*

1. PENTSTEMON *laevigatum*, Willd. Sp. Pl. 3, p. 228; Pursh, 2, p. 427.

2. P. *digitalis.* Glaberrimum; foliis caulinis connatis ovato-lanceolatis acuminatis repando-denticulatis; calicibus viscosis, laciniis acuminatis reflexis; corolla magna subcampanulata, appendice superne barbato.—*Hab.* In wet woods and prairies; common. Flowering in May.—*Obs.* Allied to P. campanulata. Perennial. Leaves broad; panicle naked, trichotomous, few-flowered, ultimate branches and calix viscidly pubescent; corolla similar to digitalis, pure white and minutely pubescent, the tube exserted, orifice inflated, subcampanulate and terete; the upper lip a little shorter than the lower and coarctate, the inferior 3-lobed and dilated, the margin of the orifice on the lower side sometimes bearded; sterile filament or appendage partly exserted, longitudinally bearded; anthers smooth, dark purple.

3. P. **tubaeflorum.* Foliis ovatis connatis denticulatis glabris; caule nudiusculo elato; calice corollisque viscoso-pubescentibus, laciniis ovatis; corolla tubaeformi, limbo intus villoso, appendice barbato.—*Hab.* In wettish prairies, from Fort Smith to Red river. Flowering in May and June.—*Obs.* Perennial. Radical leaves elliptic-ovate, entire and smooth, cauline all situated towards the base of the stem,

lower ones oblong-ovate; stem two or three feet high, the leaves so small and remote above as to give it the appearance of being naked; segments of the calix appressed; corolla of a pure white, not plaited beneath, segments oval; the whole orifice and tube villous. A very beautiful species, with the flowers rather small and crowded as it were in verticillate clusters.

4. P. **Cobaea.* Puberulum, caule pumilo; foliis oblongo-ovatis argute serrulatis nitidis; floribus pubescentibus maximis inflatis purpureis, intus striatis; calice laciniis ovatis; appendice longitudinaliter barbato.—*Hab.* In the sterile and denudated portions of the prairies of Red river, in calcareous soil. Flowering in May.—*Obs.* Perennial. Upper leaves ovate, beneath slightly pubescent; flowers by pairs; leaves broadish and thick; calix viscidly pubescent, segments oblong-ovate; flowers bluish purple, nearly as large, and almost of the same form as those of Cobaea scandens!; stem about a span high.

Orobanche *biflora*, Gen. Am. vol. 2, p. 59 (O. uniflora, Lin.).—In the Osage prairie, near the Verdigris river.

Capraria *multifida.*—*Obs.* Calix 5-parted, the segments subulate; corolla tubular, subbilabiate, base of the tube somewhat globose, border 4-lobed; lobes rounded, upper segment emarginate, the lower ones entire; capsule ovate, 1-celled, 2 and at length 4-valved; seeds very numerous and minute; duration annual; leaves opposite and ternate, lyrate, partly twice trifid, the segments linear-oblong and obtuse. This genus appears to be divided, and requires revision with living specimens. I have elsewhere proposed this plant as a genus distinct from the true Caprarias by the name of Leucospora.

Buchnera *Americana.*—The specimens uncommonly large.

ACANTHACEAE.

1. Ruellia *strepens.*

2. R. **humilis.* Erecta, hirsuta; foliis oblongo-ovatis integriusculis sessilibus; pedunculis 1—3-floris; calicis laciniis filiformibus tubo corollae duplo brevioribus.—*Hab.* On rocks in the upland forests and prairies.—*Obs.* Perennial. Stem seldom exceeding a span; the

leaves and flowers very similar to those of R. strepens, but sessile and not perfectly entire. Flower pale blue, commonly two inches long.

1. Justicia *ensiformis*, Walter, p. 63 (J. pedunculosa, Mich. Flor. 1, p. 7). 2. J. *humilis*, Mich. Flor. 1, p. 8.—Around New Orleans.

Dicliptera *resupinata*, Vahl. Enum. 1, p. 114 (Justicia brachiata, Pursh, 1, p. 14). Floribus axillaribus subsessilibus pedunculatisque subverticillatis, bracteis bivalvibus subcordatis, foliis ovatis.—*Hab.* In shady alluvial forests throughout the Arkansas territory; common.—*Obs.* Perennial. Stem erect, low, and considerably branched, hexangular, and on two of the sides grooved, sometimes striking out roots from its base; leaves in full grown plants from one to two inches wide, and five or six inches long, upon longish petioles, and minutely and unequally pubescent; floral branchlets axillary and terminal, the clusters subsessile, irregularly 3 to 6-flowered; bracts concealing the calix, which is simple and very small, with subulate segments; corolla bilabiate, pale violet purple, rather small, lobes oblong, undivided, reflected, and almost equal in magnitude, the upper slightly tridentate at the extremity and maculate at the base, the lower 2-toothed, the tube compressed and contorted; filaments two, diantheriferous; style undivided; capsule suboval, mucronulate, sessile and compressed, the valves membranaceous, attached to a curved cartilaginous border, which springing apart at the summit, becomes straight, divides the valves in the centre and separates them from their base, so as to present an appearance not very dissimilar to the blades of a pair of shears; retinaculum divided, springing upwards, each portion 1 or 2-toothed, but seldom more than 1-seeded; seed orbicular and compressed, brown and hispid.

BIGNONIACEAE.

1. Bignonia *capreolata*. 2. B. *radicans*.

Catalpa *cordifolia*.—On the banks of the Mississippi, near the settlement called the Big Prairie, a few miles below New Madrid, but apparently only naturalized. I have since observed this tree truly indigenous on the banks of the Chatahoochee, near Columbus in Georgia, and pretty frequent in West Florida and Lower Alabama.

MYOPORINEAE.

Avicennia *nitida?*—Near the outlets of the Mississippi, and on the sea islands near the Balize; called improperly, by the fishermen, Mangle.

VERBENACEAE.

1. Verbena *urticifolia.* The root is said to be a tonic, useful in intermittent fever. 2. V. *hastata.* 3. V. *bracteosa.* 4. V. *stricta.* 5. V. *Caroliniana.* 6. V. *rugosa*, Willd. Enum. 633.

Glandularia, Gmelin. Calix tubulosus quinquedentatus, dentibus setaceis inaequalibus; corollae limbus quinquefidus subaequalis, lobis emarginatis, ore villoso; stamina quatuor; stigma bilabiata; semina quatuor. Foliis trifidis laciniatis oppositis; spica solitaria pedunculata, corolla Buchnerae.

1. G. *Aubletia.* Assurgens, foliis trifidis incisis hirsutis, seminibus laeviusculis (Verbena Aubletia, Ait. Kewens, 1, p. 33; Mich. Flor. 2, p. 13; Jacq. Hort. Vind. 2, p. 82, t. 176; V. longiflora, Lamarck, Illust. 1, p. 57; Jussieu, Gen. Pl. p. 109; Buchnera Canadensis, Lin. Mant. p. 88; Glandularia Carolinensis, Gmel. Syst. Nat. 2, p. 920). —*Hab.* Every where common in elevated prairies throughout the Arkansas territory.

2. G. **bipinnatifida.* Suberecta, hirsuta; foliis trifidis bipinnatifidis, laciniis linearibus, seminibus impresso-punctatis.—*Hab.* On the open calcareous hills of Red river. Flowering in May and June.—*Obs.* Perennial. Leaves trifid, divisions trifidly pinnatifid, somewhat hirsute; bracts subulate, longer than the calix; calix tubular, dentures subulate unequal, the lowest segment very short; tube of the corolla nearly straight, longer than the calix; border large and flat, 5-cleft, lobes obcordate and emarginate, with the orifice villous; stamina four, fertile, didynamous and included; style at length exserted; stigma bilabiate, the lobes unequal; corolla lilac blue, the border equal and similar to that of Aubletia, which species the whole plant strongly resembles. These two similar species, with several more South Ameri-

can ones, appear to justify their separation from Verbena, which had formerly been attempted by Gmelin.

Zapania *nodiflora.*

Callicarpa *Americana.*—On the banks of rivers; common.

LABIATAE.

1. Salvia *lyrata.* 2. S. *Claytoni*, Elliott, Bot. Carol. 1, p. 32.

3. S. **longifolia.* Puberula, foliis lineari-lanceolatis acutis integris, radicalibus villosis serratis; calice trifido, caule pumilo.—*Hab.* In the prairies not uncommon.—*Obs.* Perennial. Nearly allied to S. azurea, but bearing flowers of nearly double the magnitude, and of a pale blue. The plant also possesses the fetid odour of Salvia sclarea.

1. Monarda *mollis*, Pursh, 1, p. 18 (M. altissima? Muhl. Catal. p. 3).—*Obs.* Stem two or three feet high, brown and glaucous, sometimes pubescent, but with the angles always obtuse; leaves long, ovate-lanceolate, acuminate and deeply serrate, lighter coloured beneath, but very slightly pubescent; bracts cordate-ovate; clusters of flowers single, uncommonly large; calix glandular and smooth, pilose at the summit dentures very short; corolla pale purple (and in one variety white); apex of the upper lip attenuated, remarkably and singularly bearded, so as to be in this way distinguished from every other species.—*Hab.* From Canada to the southern extremity of the Arkansas territory; common.

2. M. *fistulosa*, Willd. Sp. Pl. 1, p. 124; Ph. 1, p. 18.

3. M. *Russeliana.* Gracilis, foliis ovato-lanceolatis acuminatis remote serratis brevi petiolatis hirsutis, caule acutangulo, capitulis simplicibus, bracteis coloratis, corollis maculatis.—*Hab.* In shady woods around Fort Smith, Belle Point; common. Flowering in May.—*Obs.* Perennial. Stem about a foot high, angles acute and somewhat hispid; leaves hirsute, lower ones cordate-ovate, serrate; bracts pale red; calix equal, pilose, the segments divaricate, glandular and hispid; corolla white, the lower lip spotted with carmine red and undulated, the apex 3-lobed, middle lobe elongated; tube slender; stamina exserted; anthers at first red, lobes divaricate; stigma simple, subulate.

(*Coryanthus.)† Corolla ringens; labio superiore fornicato carinato, apice emarginato, filamentis subaequali; labio inferiore trilobo.

4. M. **aristata.* Foliis lineari-lanceolatis serratis acutis glabriusculis, floribus verticillatis, corollis maculatis, calicis dentibus longissime aristatis, bracteis coloratis multi-seriatis.—*Hab.* In the plains of Red river, and rarely on the upper part of the Arkansas. Flowering in May and June.—*Obs.* Perennial and annual; stem obtuse-angular, covered with a minute pubescence, the axills commonly bearing clusters of lesser leaves; bracts oblong, purplish-blue, awned and ciliated, consisting of many series; calix cylindric and striated, the orifice closed with villous hairs, the dentures equal with each other, awned, the awns bearded and nearly equal to the length of the calix; corolla almost white, sparingly spotted, and chiefly on the under lip. Allied to M. punctata, and with it forming a subgenus, characterized by the carinated upper lip as long as the stamina.

5. M. *punctata.*—Common on the banks of all the larger western rivers, and in old fields.

Cunila *mariana.*—From the Cadron to Red river, on woody hills.

1. Hedeoma *hirta*, Gen. Am. vol. 1, p. 16 (H. hispida, Pursh, Flor. Am. Septent. 2, p. 414).—*Hab.* In denudated prairies near Belle Point Fort, Arkansas.

2. H. **Arkansana.* Caule ramoso; foliis lineari-lanceolatis, antice subserratis, superioribus integerrimus; verticillis subquadrifloris, pedicellis ad basin bibracteolatis; floribus tetrandris.—*Hab.* In moist and rocky prairies near the sources of the Kiamesha river. Flowering in May and June.—*Obs.* Nearly allied to H. glabra, and possessing the pennyroyal odour; the whole plant smooth and glandular, four to six inches high; pedicells nearly equal to the cylindric calix, the dentures setaceous; corolla subcampanulate, blue, with the palate white.

Collinsonia *Canadensis.*—Common.

1. Lycopus *virginicus.* 2. L. *vulgaris.*

3. L. *sinuatus*, Elliott. Caule simplici; foliis majusculis, omnibus pinnatifidis, laciniis lineari-lanceolatis, acutis, subserratis; calicibus

† From κόρυς a helmet, and ανθος a flower; in allusion to the characteristic distinction of this section, the galcated upper lip.

acutis.—*Hab.* On the banks of the Arkansas, occasionally inundated. The plant large, and with the axills many-flowered.

NEPETA *cataria.*—Introduced and naturalized.

1. HYSSOPUS *nepetoides.* 2. H. *scrophulariaefolius*, Pursh, 2, p. 406.

MENTHA *borealis*, Mich. Flor. Am. 2, p. 2; Pursh, Flor. 2, p. 405.

TEUCRIUM *virginicum*, Willd. Sp. Pl. 3, p. 22.

GLECHOMA *hederacea*, Willd. Sp. Pl. 3, p. 85.

LAMIUM *amplexicaule*, Willd. Sp. Pl. 3, p. 90.

STACHYS *aspera*, Mich. Flor. Am. 2, p. 5; Pursh, 2, p. 407. 2. S. *hyssopifolia*, Mich. 2, p. 4; Pursh, 2, p. 407.

MARRUBIUM *vulgare*, Willd. Sp. Pl. 3, p. 111.—Naturalized.

PYCNANTHEMUM *incanum*, Mich. 2, p. 7; Pursh, 2, p. 409. 2. P. *linifolium*, Pursh, 2, p. 409 (Brachystemum linifolium, Willd. Enum. p. 623). 3. P. *virginicum*, Gen. Am. vol. 2, p. 33 (P. lanceolatum, Pursh, 2, p. 410). 4. P. *muticum*, Persoon's Synopsis, 2, p. 128 (Brachystemum muticum, Mich. Fl. Am. 2, p. 6). 5. P. *pilosum*, Gen. Am. vol. 2, p. 33.

MELISSA *officinalis*, Willd. Sp. Pl. 3, p. 146.—Naturalized.

CALAMINTHA *nepeta*, Pursh. Fl. Am. 2, p. 413.—Naturalized.

1. DRACOCEPHALUM *virginianum*, Willd. 3, p. 149, *β album.*—This is the prevailing variety, bearing flowers which are nearly white.

2. D. **intermedium.* Floribus spicatis remotis, foliis lineari-lanceolatis subdenticulatis, calicibus brevibus.—*Hab.* On the prairies in moist places, from Arkansas to Red river.—*Obs.* A much smaller species than D. virginianum, and more nearly allied to D. denticulatum, but differs in its acute and partly entire leaves, and the peculiar shortness of the calix; the colour of the flower is of a pale purple, often almost white. Nearly allied to D. variegatum, but with a different flower.

CLINOPODIUM *vulgare*, Willd. Sp. Pl. 3, p. 131; Pursh, 2, p. 410.

ORIGANUM *vulgare*, Willd.; Pursh, Flor. Am. 2, p. 411.

1. TRICHOSTEMA *dichotoma*, Lin. 2. T. *linearis*, Gen. Am. vol. 2, p. 39.—*Hab.* On the hills of the Cadron, and precisely similar to the eastern plant.

1. SCUTELLARIA *lateriflora*, Willd.

2. S. *parvula*, Mich. Fl. Am. 2, p. 11; Pursh, 2. p. 412.—*Obs.* In

this small and very pubescent species, which is not more than three or four inches high, the root presents moniliform tubers and sends out creeping shoots, the leaves are also subserrate, and the flowers very small. It inhabits the clefts of rocks, in somewhat shady places.

3. S. *versicolor*, β **mollis.—Obs.* This variety differs considerably from the common species of the western states, to which I applied the name of versicolor, rather than that of cordifolia, given to it by Muhlenberg, as there are several other species with heart-shaped leaves. The present variety, for such I consider it, is, like the original species, a plant of rather unusual magnitude in the genus, every where softly pubescent, but not glandular, and with the dentations of the leaves rather acute than obtuse; the flowers are also larger, and nearly of a deep and uniform blue colour.—*Hab.* In the vicinity of thickets on the prairies of Red river; somewhat rare.

Prunella *vulgaris*, Willd. Sp. Pl. 3, p. 176.

Phryma *leptostachya*, Willd. Sp. Pl. 3, p. 179.

ASPERIFOLIAE.

Myosotis *verna*, Gen. Am. Appendix.—*Obs.* Perhaps only a variety of M. arvensis, but certainly indigenous.

1. Cynoglossum *officinale.* 2. C. *virginicum*, Lin. Sp. Pl. 134 (C. amplexicaule, Mich. Fl. Am. 1, p. 132).

1. Lithospermum *arvense*, Willd. Sp. Pl.; Pursh, 1, p. 131.

2. L. **tenellum.* Seminibus glabriusculis convexis, foliis linearibus acutis strigosis, floribus remotis pedunculatis; calicibus foliaceis, laciniis inaequalibus.—*Hab.* In arid places in the prairies of Red river. Flowering in June.—*Obs.* Annual. Stem about a span, slender and somewhat branched, and, as well as the rest of the plant, clothed with short appressed whitish hairs; leaves very narrow, and attenuated at either end; flowers somewhat scattered, small and white; calix 5-leaved, the leaflets of unequal size; corolla funnel-formed, the border 5-lobed, the lobes oblong, at first plaited; orifice pervious; tube slender, roundish, and staminiferous towards the base; stigma small and slightly bifid; nuts four, externally convex and somewhat pilose, internally connivent

and angular, attached somewhat obliquely to the inconspicuous base of the style, and with the umbilicus imperforate. Perhaps not precisely a Lithospermum, bearing indeed some affinity to Cynoglossum, and by no means according with the usual character of the fruit of this genus as described by Roemer and Schultes, in their recent and greatly augmented edition of the Systema Vegetabilium, vol. 4, p. 6.

1. BATSCHIA *Gmelini*, Mich. Fl. Am. 1, p. 130; Pursh, 1, p. 132. —*Hab.* In the woods of Arkansas and Red river. 2. B. *canescens*, Mich. Flor. Am.; Ph. 1, p. 132. 3. B. *longiflora*, which is the Lithospermum angustifolium of Muhlenberg's Herbarium.—*Obs.* All the species of this genus are, with apparent propriety, referred by the celebrated Lehman to the genus Lithospermum.

PULMONARIA *virginica*, Willd.; Pursh. 1, p. 130.

HELIOTROPIUM *curassavicum.* Foliis oblongo-lanceolatis carnosis glaucis oppositis alternisque, spicis conjugatis compositisve, caule procumbente. (H. curassavicum and H. chenopodioides, Humboldt and Bonpland; Willd. Enum. Hort. Berol. 1, p. 175, and Sp. Pl. 1, p. 743.) —*Hab.* On the sandy banks of the Great Salt river, and in similar situations on those of the Arkansas; also on the shores of both the Atlantic and Pacific oceans, chiefly in the tropical regions.

TIARIDIUM. Corolla hypocrateriformis, tubo angulato, fauce coarctata quinqueradiata, limbi laciniis undulatis; stylus brevissimus, stigmate capitato; nuces 4, biloculares, mitriformes, acuminatae, cohaerentes, basi clausae. Receptaculum commune manifestum nullum. Lehman's Asperifoliae, p. 13.

T. *Indicum* (Heliotropium Indicum, Lin.; Willd.; Pursh, 1, page 130.

PURSHIA *scabra*, Roem. and Schultes, 4, p. 57.—*Hab.* On hills in the prairies of Red river, and on the uplands of the Arkansas; frequent. —*Obs.* Both in this species and P. hispida, the segments of the corolla are acute.

*EUPLOCA.† Calix quinquepartitus; corolla subinfundibuliformis, limbo plano plicato quinquangulato, fauce nuda; genitalibus inclusis;

† From πλέκω to plait; in allusion to the peculiar character of the corolla.

stigma annulata, apice barbata; semina quatuor, per paria approximata, angulata, basi imperforata obliqua, calici affixa.

Herbacea; folia aspera alterna; flores sparsi, limbo plicato convolvulaceo. Messerschmidiae Arguziaeque affinis, sed fructu diversa.

1. E. *convolvulacea.*—*Descript.* Root annual, slightly branched; stem angular, four to six inches high, sending out a few branches, sometimes both at the base and the summit; leaves mostly alternate, the lowest ones opposite, and, as well as the most part of the plant, asperate with very scabrous appressed hairs, their form ovate and entire, supported on short petioles; flowers lateral, approximating and subsessile; calix 5-parted, shorter than the tube of the corolla, the segments linear-lanceolate; corolla white, externally pilose, about the size and form of that of Ipomoea coccinea; the tube ovate, contracted both at its base and summit, the stamina inserted below its middle; border flat, plaited and membranaceous, with five angles; stamina, filaments none; anthers sessile and connivent, situated towards the middle of the tube, ovate and acute, opening internally, with the membranes of the cells narrowed upwards and diagonally plaited; style included; stigma annulate, hirsutely bearded at the apex; seeds four, hairy, approximating by pairs, externally convex, but flat and smooth at the commissure or point of mutual approximation, with the umbilical hilum situated above the middle of the third and narrowest side of the seed, in immediate connection with the quadrifid base of the style; receptacle compressed, and at length separated from the base of the style; cotyledons and radicle incurved towards the umbilicus.

Hab. On the sandy banks of the Arkansas. Flowering in June, the flowers of an agreeable odour, and opening towards sunset, as in the Mirabilis! Perhaps this plant ought to be united with the Arguzia of Siberia, which requires ulterior examination; though from the description of Messerschmidia incana of Meyer, said to be closely allied to Arguzia, and of the fruit of which a very minute description is given in the fourth volume of the Systema Vegetabilium of Roemer and Schultes, page 306, our plant is very essentially and generically distinct.

HYDROPHYLLEAE.

1. Ellisia *microcalyx. Glabriuscula, decumbens, foliis lyrato-pinnatifidis longe pedunculatis, laciniis paucis (3—5) lateralibus obliquis inciso-dentatis intermedio trifido obtuso; floribus solitariis minutis. (Hydrophyllum pusillum, Muhl. Herb.)—Annual. The leaves very slightly hairy, upon long petioles, in three to five divisions; the lateral segments half reniform, toothed, the terminal division nearly entire, but trifid; calix minute; corolla very small, subcampanulate, with five shallow lobes.—*Hab.* In Arkansas, Alabama, &c.

2. E. *ranunculacea. Subhirsuta, caule procumbente; foliis pinnatifidis subquinquelobatis, superioribus tripartitis, inciso-dentatis obtusis longe petiolatis; racemis secundis paucifloris.—*Hab.* In the shady humid alluvial forests of the Arkansas, frequent. Flowering in March.

Descript. Annual. Stems diffuse and procumbent, about a span in length; the upper leaves 3-parted, the lateral segments toothed on the lower side (the very reverse of the preceding species), the central segment trifid; racemes 5 to 10?-flowered; flowers upon longish pedicells; corolla pale blue, cylindric-campanulate, naked, segments suboval and entire; germ hirsute.—*Obs.* The leaves, which are much less compound, differently formed, and furnished with conspicuous petioles, readily distinguish this species from the E. ambigua.

Hydrophyllum *virginicum*, Willd. Sp. Pl. 1, p. 814; Ph. Flor. Am. 1, p. 134.

1. Phacelia *hirsuta. Caule erecto ramoso; foliis pinnatifidis, superioribus sessilibus, segmentis integriusculis; calix, laciniis linearibus patentibus; corolla, lobis integris nudis; filamentis basi barbatis.—*Hab.* In sylvan prairies; common from the Cadron to the garrison at Belle Point, Arkansas. Flowering in April and May.—*Obs.* Annual and perhaps also biennial. The whole plant hirsute and hairy; stem six to twelve inches high, commonly branching from the base; upper leaves not amplexicaule, but closely sessile, pectinately-pinnatifid, the segments of the lower leaves sparingly toothed and obtuse, those of the upper linear and entire; spike simple, rarely bifid; pedicells longer than the

calix; calix hirsute, the segments linear; corolla pelviform-campanulate, purplish blue, 5-grooved, the grooves naked and melliferous; capsule ovate and hirsute, 4 to 8-seeded (the germ 8 to 10-seeded).

2. P. **glabra*. Erecta; foliis pinnatifidis, superioribus amplexicaulibus ciliatis, segmentis integriusculis; calix, laciniis ovatis; corolla, lobis integris nudis; filamentis basi barbatis.—*Hab.* In humid and elevated woods on the margins of rivulets, near the Dardanelle settlement, Arkansas river. Flowering in April.—*Obs.* Very similar to the preceding; growing, however, not more than five or six inches high. The stem terete and branched from the base; leaves pinnatifid, the lower ones petiolate, the segments, three or four pair, are somewhat incisely toothed and obtuse; the upper ones amplexicaule, pectinately pinnatifid, with the same number of ciliately acute segments; calix subcampanulate, the segments ovate and ciliate; corolla lilac blue, pelviform-campanulate, rather large and externally pilose, semiquinquifid, the lobes suboval; ten purplish spots at the base of the corolla; stamina somewhat exserted, equal with the corolla, bearded at the base; anthers blue; style filiform, bifid; capsule smooth, 4 to 8-seeded.

NEMOPHILA. Calix decemfidus, laciniis exterioribus reflexis; corolla subcampanulata quinquelobata, lobis emarginatis, ad basin foveolis marginatis staminiferis; stamina brevia, filamentis nudis; capsula carnosa unilocularis, bivalvis; semina quatuor.

Herba succulenta annua, caule triquetro; foliis alternis pinnatifidis; pedunculi longissimi uniflori oppositifolii et terminales, subracemosi, racemis incurvis fructibus deflexis; corolla aestivatione convoluta. Hydrophyllo affine.

N. *phacelioides.* Root fibrous, annual, but more commonly biennial; stem fragile, smooth, somewhat tender and diaphanous, plano-convex, twelve to eighteen inches long, branching from the base and decumbent, possessing a tenacious and elastic centre; leaves alternate, pinnatifid, somewhat succulent, and on the upper surface a little scabrous; segments five or six pair, subovate or lanceolate, acute, partly falcate, and presenting a few incisions; petiole ciliated, its internal base lanuginous; peduncles 1-flowered, terete, very long, sometimes near a span, and attenuated towards their extremities, at first remote and coming out opposite the leaves, but at length, as the period of inflorescence advances, approximating into a kind of raceme, which is primarily curved; calix campanulate, 10-cleft, the segments ovate and acute, ciliate, the larger connivent and erect, the exterior much smaller and reflected; corolla pelviform-campanulate, violet-blue, the lobes oval and naked, obliquely emarginated, before expansion convolute; the exterior base producing ten purple spots, the internal base furnished with five foveolate nectariferous cavities, with tomentose margins bearing the stamina; stamina about half the length of the corolla, the filaments filiform and smooth; anthers sagittate-oblong, brownish-yellow; style one, bifid, below hirsute; capsule oval, covered by the connivent calix, somewhat hirsute, 1-celled, 4-seeded, the seeds by pairs, alternately immersed in a fleshy succulent receptacle, occupying the whole cavity of the capsule.—*Hab.* In the shady woods of Cedar prairie, ten miles from Fort Smith, and from thence in similar situations to the sources of the Pottoe. Flowering in May.

SOLANEAE.

1. Solanum *nigrum*, Lin. 2. S. *Carolinense*, Willd. Sp. Pl. 1, p. 1043; Pursh, 1, p. 156.

3. S. *triflorum.*—Towards the sources of the Arkansas, and near the burrows of the American Marmot.—Dr James. In the same situations grew also a hirsute variety.

1. Physalis *pubescens*, Willd. p. 1023; Feuil. Peruv. 3, t. 1 (P. obscura, β pubescens, Mich. Flor. Am. 1, p. 149; Pursh, 1, p. 157?).—According to Father Feuille, the fruit is edible, as in the United States.

2. P. **pumila.*—*Obs.* Perennial. Somewhat hirsutely pubescent; stem erect, twelve to eighteen inches; leaves ovate-lanceolate, apparently entire and solitary, attenuated down the petiole, which is very distinct; segments of the calix acuminate.—The habit very much that of Atropa.

3. P. **longifolia.* Glaberrima, caule angulato erecto, foliis solitariis ovato-lanceolatis acuminatis sinuato-dentatis longe pedunculatis, floribus solitariis pendulis.—*Obs.* Herbaceous; root perennial; stem angular, about eighteen inches high, and branching above; leaves

smooth, four to five inches long, irregularly, sparingly and sinuously toothed; flowers, as usual, yellowish, with five brown blotches towards the base; calix much larger than the berry. It bears much the aspect of Capsicum annuum, and, from the diagnosis, appears allied to P. chenopodifolia.—*Hab.* On the sandy banks of the Arkansas, near Belle Point. Flowering in June.

4. P. **mollis.* Tomentosa, incana, foliis geminis subrhomboideo-ovatis cordatisve sinuato-dentatis longe petiolatis undatis, floribus solitariis pendulis.—*Obs.* Perennial and herbaceous, the root creeping, the whole plant covered with a stellate, short and whitish pubescence. About twelve to eighteen inches high, and branching above; leaves below somewhat cordate-ovate, the upper ones ovate, tending to rhomboidal acute, the margin unequally and sinuately toothed; flowers solitary, axillary, ochroleucous; calix inflated, larger than the berry. Before flowering, the plant bears very much the aspect of Rivina humilis. —*Hab.* On the sandy banks of the Arkansas. Flowering in June.

Datura *stramonium*, Lin.

1. Verbascum *thapsus*, Lin.

2. V. *blattaria*, Lin.—*Obs.* There is no species of this genus indigenous to America.

CONVOLVULACEAE.

1. Convolvulus **hastatus.* Foliis hastato-pedatis sericeis, laciniis intermediis sublanceolatis caeteris multo majoribus.

Descript. Root perennial; stem twining, herbaceous and pubescent; leaves petiolated, on either surface covered with a short, hoary and silky pubescence, the primary ones simply hastate, the rest partly palmated, about two inches long, commonly producing on either side of the base two lateral, reflected and toothed, or almost entire lobes; the central segment more than twice their length, and double their breadth; peduncles solitary, mostly 2-flowered, much longer than the leaves, the pedicells each producing two bracts; segments of the 5-leaved calix externally pubescent, imbricated, oval and obtuse, tinged with purple; corolla rose-coloured?; stigmas two, filiform; capsule 2-celled, cells 2-seeded.—*Hab.* On the high hills of Red river, contiguous to the confluence of the Kiamesha. Flowering in June.—*Obs.* This plant differs but little apparently from the C. althaeoides of the south of Europe and Africa, as described by Linnaeus. Clusius observed this species in Spain and Portugal; it grows also on hills in the vicinity of Naples, and in the adjacent islands and continent.

2. C. *arvensis*, Lin. Sp. Pl. 218; Eng. Bot. t. 312.

3. C. *panduratus*, Willd. Sp. Pl. 1, p. 850.—A variety with entire leaves.

1. Ipomoea *coccinea*, Willd. Sp. Pl. 1, p. 880; Plumier Pl. Amer. t. 103; Bot. Mag. 221.

2. I. *lacunosa*. Foliis cordatis acuminatis scrobiculatis? basi angulatis; pedunculis subunifloris, flore brevioribus. Lin. Sp. Pl. (Ed. III.) p. 228.—*Obs.* As remarked by Linnaeus, very similar to I. coccinea, but with peduncles bearing only one or two pale purple, and in the Arkansas plant, white flowers, short and somewhat campanulate. The leaves are very thin, not scrobiculate (that I can perceive), and with very long acuminated points.—*Hab.* Rather abundant on the banks of Arkansas. Flowering in midsummer and through the autumn.

3. I. *nil* (Convolvulus nil, Willd. Sp. Pl. 1, p. 851).

4. I. *tamnifolia*, Willd. Sp. Pl. 1, p. 885.—*Hab.* Banks of the Mississippi.

1. Evolvulus *nummularius*, Willd. Sp. Pl.—*Hab.* Banks of the Mississippi.

2. E. *pilosus*. Erectus, foliis lineari-oblongis utrinque sericeo-pilosis, pedunculis unifloris brevibus. Nuttall's Gen. Am. Pl. 1, p. 174 (E. Nuttallianus, erectus, foliis oblongis utrinque sericeo-tomentosis, pedunculis unifloris brevibus. Schultes, Syst. Veg. vol. 6, p. 198; E. argenteus, Pursh, 1, 187).—*Obs.* Flowers purplish, coming out about the middle of the stem; peduncle shorter than the calix; calix segments partly linear and acuminate.—*Hab.* On the high hills of Red river near Kiamesha.

Dichondra *repens*. Foliis reniformibus emarginatis subtus pubescentibus. Willd. Sp. Pl. 2, p. 1353 (D. Carolinensis, Mich. Flor. Am. 1, p. 136).—*Hab.* Banks of the Mississippi near New Orleans.—*Obs.* From an inspection of many specimens, compared with Lamarck's figure (Ill. t. 183), no difference is discernible, and the leaves of the American plant are more frequently emarginated than otherwise.

Cuscuta *Americana*, Willd. Sp. Pl. 1, p. 702.

HYDROLEAE.

Hydrolea **ovata*. Spinosa, puberula, foliis ovatis utrinque acutis, floribus corymbosis laciniis ovatis, calicibus hirsutis.

Descript. Perennial. The whole plant covered more or less with a minute and soft pubescence. Stem about eighteen inches high, herbaceous, branching only at the period of flowering; leaves of the radical shoots almost linear and crowded, those of the stem elliptic, ovate, acute at either end, and entire on the margin; the axills commonly producing slender solitary spines, being apparently so many abortive branchlets; flowers bright blue, crowded towards the summits of the fastigiate branchlets; calix 5-cleft, hairy, the segments linear-lanceolate; corolla pelviform-campanulate, with ovate segments somewhat larger than those of H. spinosa, as figured by Aublet; stamens about the length of the corolla; styles filiform, two and three; capsule 2 and 3-valved; seeds numerous and minute.—*Hab.* On the margin of ponds throughout Arkansas.

POLEMONIACEAE.

Polemonium *reptans*, Willd. Sp. Pl. 1, p. 886.—On the banks of the Mississippi; rare.

1. Phlox *paniculata*, Willd. Sp. Pl. 1, p. 839.

2. P. *maculata*, Willd. Sp. Pl. 1, p. 840.

3. P. *pilosa*, Willd. Sp. Pl. 1, p. 840 (Phlox aristata, Mich. Flor. Am. 1, p. 144); Icon. Pluk. Alm. 133, t. 98, f. 1.

4. P. **glomerata*.

5. P. *reptans*, Mich. Flor. Am. 1, p. 144 (Phlox stolonifera, Bot. Mag. 563).

Cantua *coronopifolia*, Willd. Sp. Pl. p. 879 (Cantua thyrsoides, Jussieu in Annales du Mus. 3, p. 119; Ipomopsis elegans, Mich. Flor. Am. 1, p. 141; Ipomeria coronopifolia, Nuttall's Gen. Am. vol. 1, p.

124).—*Obs.* Differs from Cantua merely by the angular seeds.—*Hab.* On the elevated prairies of Red river, where the flowers are of a bright scarlet, and spotted with a deeper tinge of colour.

JASMINEAE.

Olea *Americana*, Willd. Sp. Pl. 1, p. 45; *Ic.* Catesb. Carol. 1, t. 61.—*Hab.* On the banks of the Mississippi near New Orleans.

GENTIANEAE.

Gentiana *linearis*, Willd. Sp. Pl. 1, p. 1339 (G. puberula, Mich. Flor. Am. 1, p. 176).

Lisianthus *glaucifolius.* Foliis ovato-oblongis sessilibus, pedunculis elongatis unifloris, laciniis corollae tubo longioribus. Lamarck, Encyc. p. 660; Jacquin. ic. rar. 1, t. 33; Collect. 1, p. 64.—*Obs.* This plant is so accurately described by Lamarck, that any thing additional is almost superfluous. It is a glaucous, somewhat thick and smooth leaved herbaceous perennial, of low growth, with a terete dichotomously branched stem. The peduncles are long, bearing large funnel-formed and somewhat spreading flowers of a violet purple, considerably darker at the base and within the tube; the segments are very deep, oval and acute, and the calix segments much acuminated; the stigma large, capitate and bilamellate; the capsule 2-celled; the seeds numerous, round and punctate, but without margins. The whole plant, by habit, evidently approaches the genus Gentiana.—*Hab.* On the sandy banks of the Great Salt river of Arkansas; rare. It has flowered at Mr William Bartram's botanic garden, Kingsessing near Philadelphia, in September, and appeared to be sufficiently hardy to withstand the climate.

All the species of this genus (twenty-three in Persoon's Synopsis), except two in Madagascar, are indigenous to the islands of the West Indies and the kingdom of Peru.

1. Sabbatia **campestris.* Erecta, foliis ovatis amplexicaulibus, pedunculis elongatis subfastigiatis, calicibus alatis, laciniis linearibus; corollam 5-partitam superantibus.

Descript. Annual and bitter; stem angular, about one foot high, branches dichotomous, peduncles few, elongated, and forming a straggling corymb; leaves ovate, amplexicaule and acute, 3 to 5-nerved; calix somewhat longer than the corolla, segments linear-lanceolate, the angles of the junction of the segments salient or alated; corolla rosaceous, about the form and size of S. angularis, the segments oboval, the base of the corolla marked with a 5-rayed greenish star; anthers revolute; style one; stigma deeply bifid.—*Hab.* In the open prairies of Arkansas and Red river; common. Flowering in June and July. —*Obs.* Perfectly distinct from Chironia trinervia of Ceylon, with which, however, it agrees in the artificial character; but the plant of Ceylon produces oval leaves, acute at both extremities, large blue flowers, and is probably a genuine Chironia, a genus not yet discovered in America.

2. S. *angularis*, Pursh, Flor. Am. 1, p. 137.

Villarsia *lacunosa*, Venten. Choix de Plant., p. 9 (V. aquatica, Gmelin, Syst. Veg. 447; Menyanthes trachysperma, Mich. Flor. Am. 1, p. 126; Villarsia cordata, Elliott, Sketches Bot.).—*Obs.* This plant is dioicous and polygamous. In the plant of Mr Elliott, which grows also in the ponds of New Jersey, the leaves are larger and cordate, the stamina effoete, and the stigmas exserted. In the male plant, as commonly observed, the leaves and flowers are smaller, the anthers perfect, the stigmas small, and the germ infertile.

Spigelia *Marilandica*. Lin. Syst. Veg. p. 197; Mich. Flor. Am. 1, p. 147; *Ic.* Curt. Magaz. t. 80.—*Hab.* On the banks of the Arkansas, in the forests near to the first cliffs on the banks of the river.

ASCLEPIADEAE.

1. Asclepias *debilis*, Mich. Flor. Am. p. 116.—Rather common on the banks of the Ohio and Mississippi.

2. A. *variegata*, Willd. Sp. Pl. 1, p. 1265; *Icon.* Bot. Magaz. 1182; Pluk. Alm. t. 77, f. 1.—*Hab.* Near the Cadron settlement.

3. A. *obtusifolia*, Mich. Flor. Am. 1, p. 115.—*Hab.* Near the garrison at Belle Point.

4. A. *quadrifolia*, Jacquin, Obs. 2, t. 23 (Apocynum umbellatum

album, latiore folio, tetraphyllon, ex Terra Mariana, Pluken. Mantis. p. 16).—*Hab.* Near Belle Point Fort.

5. A. *parviflora*, Willd. Sp. Pl. 1, p. 1267 (Apocynum petraeum ramosum, salicis folio venoso, siliqua medio tumente, Virginianum, Phyt. t. 261, f. 3, mala).—*Hab.* Common along the banks of the Ohio and Mississippi.

6. A. *verticillata*, Mich. Flor. Am. 1, p. 116; *Icon.* Pluk. Mant. t. 336, f. 4.—*Hab.* Near the Cadron settlement.

7. A. *tuberosa*, Willd. Sp. Pl. 1, p. 1273; *Icon.* Dillen. Hort. Eltham. t. 30, f. 34.—*Hab.* Common both in the prairies of the Arkansas and Red rivers. Sometimes nearly scarlet.

*POLYOTUS† (Acerates, Elliott).‡ Corolla rotata reflexa; lepanthium simplex, quinquepartitum, laciniae ovatae concavae absque corniculis basi inauriculatae. Genitalia Asclepiadis, Gompholobio affine, habitu et fructificatione Asclepias.

1. P. **heterophyllus* (Asclepias viridiflora, Pursh, Flor. Am. 1, p. 181). Villosus, erectus, foliis oppositis oblongo-ovatis plerumque acutis, umbellis globosis caulinis; lepanthium antheridio subaequale.

Descript. Root perennial; stem herbaceous, simple, terete; leaves opposite, very shortly petiolate and somewhat rigid, varying in figure from ovate to oblong or elliptic, and either obtuse or acute, subhirsutely villous, a little scabrous and undulated on the margin, three inches long, by about one and a half inches broad, reticulately veined and pectinately nerved, the nerves confluent below the margin; umbells extra-axillary, dense and globose; bracts subulate; calix segments linear-lanceolate, acute; corolla rigidly reflected, segments oblong, acute, greenish; lepanthium (or nectary, L.) 5-parted, segments linear-oblong, nearly equal with the antheridium (or staminal crown), of a purplish green colour, closely appressed, concave, and scarcely auriculate at the base, devoid of awns, originating separately from the base of the antheridium; fissures of the antheridium angularly salient near the summit; cusps small and membranaceous; pollinia (masses of pol-

† From πολὺς many, and Οὖς, ὠτὸς an ear, from the empty and auriculate form of the lepanthia or nectaries.

‡ This name has been already employed for another genus.

len) even, longish stipitate, partly club-shaped, cereaceous and hyaline, deciduous, alternating in the receiving cells; follicles two, smooth and even; seeds comose, and attached as in Asclepias.—*Hab.* From Fort Smith to Red river, on rocks and in dry prairies. Flowering in June. Mr Pursh found this species from Pennsylvania to Virginia. Professor Ives discovered the same plant near New Haven, and likewise described and figured in Silliman's Journal, a lanceolate leaved variety, which he then supposed to be a new species, but which he afterwards justly regarded as a mere uncertain variety; the leaves of this species varying from oval to ovate, lanceolate and oblong, and are either flat, undulated, smooth or pubescent. The plant of Arkansas differs from that of New Haven more constantly in the colour of the lepanthium, which is somewhat brown instead of yellowish green.

2. P. *lanuginosus* (Asclepias lanuginosa, Nuttall's Gen. Am. vol. 1, p. 168). Decumbens, foliis ovatis sparsis, umbellis subsolitariis terminalibus.—*Obs.* Root tuberous; stem four to six inches high; flowers greenish. A dubious species, and requires re-examination in a living or more perfect state.—*Hab.* On dry and gravelly hills, about thirty miles below the confluence of White river with the Missouri.

3. P. *longifolius* (Asclepias longifolia, Mich. Flor. Am. 1, p. 116; Acerates longifolia, Elliott, Sketches Bot. p. 317). Puberulus, caule suberecto, foliis sparsis praelongo-linearibus acutis, umbellis caulinis pedunculatis; lepanthium stipitatum antheridio brevius, folliculis villosis.—*Obs.* Perennial and herbaceous. Stem two to three feet high, slightly pubescent; leaves half an inch wide and half a foot long, scabrous on the margin, the nerves confluent below the margin, midrib beneath pubescent; umbells many, subglobose, loose; bracts subulate; pedicells pubescent, nearly an inch in length; flowers smaller, greenish, petals obscure purple at the summit, reflected; segments of the lepanthium oblong, concave, with a purplish line near the base, shorter than the antheridium, stipitate below, and distinctly inserted; clefts of the antheridium salient at the summit; cusps membranaceous; follicles two, villous, rostrate.—*Hab.* On the margins of ponds, and in places overflowed by winter rains, from Illinois and Missouri to Red river. Flowering in June. Also in swamps near the Atlantic sea coast, from Sussex county in Delaware (*v. v.*) to Georgia.

4. P. **angustifolius.* Caule erecto, foliis linearibus sub-oppositis, umbellis caulinis subsessilibus; lepanthium antheridio sublongius, sessile, foliolis apice tridentatis.

Descript. Perennial. Stem simple, herbaceous and slender, the lower part naked, about eighteen inches high; leaves very long, narrow and acute, somewhat revolute and scabrous on the margin, one to one and a half lines wide, opposite and alternate, nerves confluent below the margin; umbells globular, small, three or four to eight; pedicells about the length of the flowers; flowers greenish, with a mixture of white; segments of the corolla oblong, reflected; lepanthium sessile, divisions linear, longer than the antheridium, tridentate above, the central denture minute, concave and auriculate below; clefts of the antheridium salient from the base to the summit; cusps broad and membranaceous, concealing the stigma; follicles two.—*Hab.* In dry prairies from Fort Smith to Red river. Flowering in June.—*Obs.* This species appears to be very nearly related to Gomphocarpus, and also very nearly to Asclepias, particularly A. cinerea, from which it merely differs in the absence of the short internal awn; it may, however, be considered as present in the central, acute and shorter third denture of the segments of the lepanthium.

Dubious Species. 5. P. *obovatus* (Asclepias obovata, Elliott, Sketches, p. 321). Foliis obovatis mucronatis, subtus tomentosis; umbellis subsessilibus; lepanthium antheridio duplo longius.—*Hab.* In Georgia.

Anantherix, Nuttall, Gen. Am. vol. 1, p. 169. Corolla subcampanulata quinquefida; lepanthium simplex, quinquelobum, lobis compressis vacuis incurvatis laminula ab apice interiori auctis; antheridium superius interdum pedicellatum. Caetera Asclepias.

Caulis erectus, herbaceus; folia alterna aut opposita, subverticillata, interdum axillis spinulosis; flores magni umbellati aut subpaniculati, terminales; folliculi muricati aut laeves. Calotropis affine.

1. A. *viridis* (Anantherix viridis, Nuttall, Gen. Am. vol. 1, p. 169; Asclepias viridis? Walter, Flor. Car. p. 107; Asclepias connivens, Baldwin in Elliott's Sketches, p. 320; Podostigma viridis, Elliott, p. 327). Foliis oppositis sessilibus obovatis oblongis mucronulatis glabri-

usculis, umbellis caulinis subpaniculatis paucifloris, lepanthii laciniis longissimis.—*Hab.* In damp pine barrens near St Mary's.

2. A. **paniculatus* (Asclepias viridis? Walter, p. 107; Pursh, 1, p. 183?). Foliis sparsis ovato-oblongis obtusiusculis mucronulatis; umbellis divisis subpaniculatis; lepanthium corolla duplo brevius; folliculis muricatis.

Descript. Perennial. Stem angular and smooth, one to two feet high; leaves scattered, numerous, ovate-oblong, shortly petiolate, nearly smooth with the margin scabrous, four or five inches long and one to one and a half broad, axills and summits of the petioles producing minute and soft spines; umbells several, terminal, rather loose, branching and few-flowered, with the flowers fastigiate; peduncles about an inch long; calix small, appressed, 5-parted, segments linear-lanceolate; corolla subcampanulate, deeply 5-cleft, divisions large and ovate, externally depressed lengthways along the centre, at all times connivent and erect, colour yellowish-green; lepanthium contiguous with the corolla, 5-lobed, variegated purple and white; lobes compressed, obtusely carinate, hollow and rounded, and thickened at the summit, with the folds closed, an internal thickish lamella arising near the internal summit closing the fold and longitudinally adnate; there are also five intercalary, obtuse and somewhat crustaceous dentures interposed betwixt the lobes of the lepanthium; antheridium roundish, obtusely pentagonal, the lateral fissures situated within the salient angles; the usual membranaceous cusps obsolete; stigma thick and discoid, pentagonal; pollinia disposed as in Asclepias, the masses somewhat scymitar-shaped, their stipes articulated; follicles two, muricated with soft spines; seeds comose.—*Hab.* In Cedar prairie near Fort Smith, and also near Red river. Flowering in May.

3. A. **decumbens.* Foliis sparsis suboppositis ovato-lanceolatis praelongis acutis; umbella subglobosa terminali; lepanthium corollae subaequale.

Descript. Perennial. Stems numerous, simple, decumbent, somewhat angular, twelve to eighteen inches long, and crowded with shortly petiolated, long and lanceolate leaves, acute and scabrous on the margin. The general aspect is similar to the preceding species, but the umbell is solitary, terminal and crowded; peduncles pubescent, about an inch long; calix as in the preceding; segments of the corolla the same colour, but shorter, scarcely covering the brown lepanthium, of which the segments are very patulous and incurved, and exceed the antheridium in length; the chasms of the antheridium are remarkably salient, angular and crustaceous; with the follicles I am unacquainted.—*Hab.* On dry hills near the confluence of Kiamesha and Red river. Flowering in July.

Subgenus. Stylandra. Laminulae lepanthii nullae; antheridium pedicellatum; folliculi laeves.

4. A. (S.) *pumila* (Stylandra pumila, Nuttall, Gen. Am. vol. 1, p. 170; Podostigma pubescens, Elliott, Sketches, 1, p. 326; Asclepias pedicellata, Walt. p. 106; Pursh, 1, p. 182). Foliis linearibus suboppositis sessilibus, corollae laciniis lepanthio subtriplo longioribus.—*Hab.* In dry pine barrens, Effingham county, Georgia, Elliott. Near St Mary's, Dr Baldwin. Near Charleston, Mr Fraser.—*Obs.* This genus, which will probably prove abundant in species, is very nearly allied to the Calotropis of R. Brown, but differs essentially in the insertion of the lepanthium and the form and character of its segments.

Enslenia, Nuttall, Gen. Am. vol. 1, p. 164. Corolla quinquepartita erecta; lepanthium simplex quinquepartitum petaloideum planum truncatum, laciniis in filum bifidum desinentibus; stigma conica subbilamellata. Caetera Asclepias.

Herba volubilis; folia opposita; flores umbellati.

E. *albida*, Gen. Am. (loc. cit.).—*Hab.* Near Fort Smith and other places along the banks of the Arkansas. Found also on the banks of the Potomac, and on the banks of the Scioto and Ohio, &c.

ARTICLE VII.

A Remarkable Arrangement of Numbers, constituting a Magic Cyclovolute. By E. Nulty, Philadelphia. Read before the American Philosophical Society, June 27th, 1834.

THE Magic Circle of Dr Franklin has been long admired, as embracing the most ingenious arrangement of numbers ever formed. It consists of *five* sets of circles, of which the first or principal includes *nine* circumferences, bounding *eight* concentric rings. These rings are equally intersected by *four* diameters or *eight* radii, on which, and in the middle of each ring, are placed the series of integral numbers from 12 to 75, both inclusive. In addition to this series, there is an auxiliary 12 occupying the common centre of the rings; and the total sixty-five numbers thus disposed, have, as respects the eight rings and eight radii, the following remarkable properties.

First. The eight numbers round each ring, with the auxiliary or central number, amount to 360, the number of sexagesimal degrees in a circle.

Secondly. The eight numbers along each radius, with the auxiliary number, amount to 360.

Thirdly. The four numbers in each semi-ring terminating in a principal diameter, intermediate between two particular radii, with half the auxiliary number, form the sum 180, the degrees in a semicircle.

Fourthly. Every four adjacent numbers in any two consecutive rings, with half the auxiliary number, give the same amount, 180.

As to the four remaining sets of circles and the rings which they form, their centres are at the four points in which the principal diameter, and a conjugate perpendicular to it, intersect the least and interior circumference. If our attention, for the instant, be confined to any one of these centres, and to the corresponding set of circles, the bounding circumferences of the exterior and interior rings will be seen to touch the greatest and least of the nine principal circumferences, at points in the principal diameter or its conjugate. According to this construction there are *five* rings between the bounding circumferences of each of the four sets of circles under consideration; and all the *twenty* rings thus constituted possess the same property with the eight rings first mentioned; or in more specific terms, the eight numbers in each of the twenty secondary rings, with the auxiliary number at the principal centre, form the sum 360.

These are the different properties comprised in the Magic Circle, left by its original and sagacious author. They certainly must be regarded as not a little curious, and would seem to require a considerable familiarity with the powers of numbers. As to the mode of investigation by which they were first discovered, we have seen no account sufficient to enable us to pronounce with any degree of confidence. We should not, however, be inclined to think that they resulted either from conjecture or trial, although they are by no means confined to the particular distribution of numbers published. We should rather be disposed to join in the opinion that they were suggested by remarks made on other arrangements previously formed. But still we are forced to believe that they must have been deduced from views which were incapable of embracing in its full extent the general problem, whence originated the present observations. The reasons which justify this conclusion will immediately appear on a glance at the drawing which accompanies this paper, and which may be regarded as a generalization of Dr Franklin's Magic Circle. The additions made are *Volutes*, commencing at the extremities of the diameters between the numbered radii; and on which account the drawing may not inappropriately be termed a *Magic Cyclovolute.*

To trace one of these curves, commence at the extremity A of the principal diameter AA′, and continue along the circle, of which the centre is *a*, nearly to the extent of a semicircle; then incline towards the least interior circle, *aa′ bb′*, and terminate in its circumference. In like manner another volute may be traced in the opposite direction, and thus will appear *two* of the volutes originating in the point A. *Six* similar volutes may be traced from the extreme points A′, B, B′; and all the *eight* viewed in pairs may be easily recognized by the four different colours in which they are delineated. Besides these volutes, we may trace *eight* analogous curves, from the extremities of the diameters intermediate between the conjugates AA′, BB′. In the drawing they may be traced by passing along circular segments, decreasing and changing their colours, whilst verging towards the interior circumference *aa′ bb′*. There will thus appear *sixteen* similar volutes, in addition to the circles first described; and all these have precisely the same property relatively to the number 360, which forms the common result of the auxiliary 12, and every eight numbers within any two consecutive boundaries.

These, we believe, are all the properties of which the arrangement of numbers constituting the cyclovolute appears susceptible; and we intended to subjoin here the investigation which led to them, and to the different changes that may be made in disposing the numbers in the drawing. We have, however, concluded to omit this investigation for the moment, and make it the subject of a supplementary note to be read at a future meeting.

Regarding the objects of the Society, this paper is presented without any desire for its publication, and chiefly in compliance with the wishes of a friend. But as the Magic Circle originated, and has, I presume, been completed in Philadelphia; and as it has been considered in Europe as the most ingenious arrangement of numbers ever imagined, the Society may not be disinclined to insert some notice of the subject in their records.

MAGIC CYCLOVOLUTE.

Secondary Circles.

		A					A′					B					B′		
51	37	44	42	49	67	21	60	26	65	27	61	20	66	25	43	45	36	50	41
34	59	29	54	32	18	75	13	70	16	74	19	69	14	72	58	35	53	30	56
36	50	41	47	38	20	66	25	63	22	44	42	49	39	46	60	26	65	23	62
53	30	56	33	55	69	14	72	17	71	29	54	32	57	31	13	70	16	73	15
26	65	23	62	24	42	49	39	46	40	50	41	47	38	48	66	25	63	22	64
75	13	70	16	73	59	29	54	32	57	35	53	30	56	33	19	69	14	72	17
61	20	66	25	63	45	36	50	41	47	21	60	26	65	23	37	44	42	49	39
12	74	19	69	14	28	58	35	53	30	68	18	75	13	70	52	34	59	29	54
12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12

360

Volutes.

A		A′		B		B′		A, B		A′, B		A, B′		A′, B′	
51	12	67	28	27	68	43	52	12	27	68	67	52	51	28	43
34	61	18	45	74	21	58	37	37	18	61	58	45	74	21	34
36	75	20	59	44	35	60	19	59	60	19	36	35	20	75	44
53	26	69	42	29	50	13	66	50	53	42	29	26	13	66	69
65	30	49	14	41	54	25	70	30	41	54	49	70	65	14	25
16	47	32	63	56	39	72	23	23	32	47	72	63	56	39	16
22	57	38	73	62	17	46	33	73	46	33	22	17	38	57	62
71	40	55	24	15	64	31	48	64	71	24	15	40	31	48	55
12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12

360

ARTICLE VIII.

Observations to determine the Magnetic Dip at Baltimore, Philadelphia, New York, West Point, Providence, Springfield and Albany. By A. D. Bache, Professor of Natural Philosophy and Chemistry, and Edward H. Courtenay, Professor of Mathematics, in the University of Pennsylvania. Read November 7th,* 1834.

THE following observations of the magnetic dip were made at places between the latitudes of 39° 17′ and 42° 39′ N. and longitudes of 71° 25′ and 76° 28′ W. In all of them a dipping needle made by Gambey for the apparatus of the Military Academy at West Point was used. This needle is provided with all the adjustments necessary to render its use accurate, and its performance is highly satisfactory. The vertical circle upon which the dip is read, is graduated to fifteen minutes, and can be read with ease to five minutes by the aid of two microscopes attached to the glass case which covers the instrument. The horizontal circle, which serves to mark the position of the plane perpendicular to the magnetic meridian, and hence to place the needle in the meridian, is graduated to half degrees, and reads by a vernier to two minutes. The axis of the needle rests upon two small agate supports, and its uniform position upon them is insured by two

* Late Professor of Natural and Experimental Philosophy at the United States Military Academy.

copper y's, which can be raised so as to relieve the needle from the agate supports, and then being depressed, restore it to its bearings upon them. A sensitive level is attached to the instrument, which is levelled by three foot screws. The two needles which accompany the instrument are in the form of very acute rhombs, in length across the longer diagonal about seven and a half inches, in breadth across the shorter diagonal three-eighths of an inch.

The method of observation usual with this kind of needle was resorted to. The eccentricity of the axis of the needle in relation to the vertical circle on which the readings were made, was corrected by readings at the two extremities of the needle. The want of parallelism of the zero line and level was corrected by turning the limb 180° in azimuth, and making two readings, one with the limb direct, the other with it reversed. The inclination of the magnetic axis to the axis of figure, was corrected by turning the needle in the y's; and the error resulting from the centre of gravity of the needle being out of the axis, by inverting the poles of the needle.

A detailed example of this method will be given to indicate the degree of accuracy to which the particular instrument in question enabled us to carry it; no special interest attaching to these details, they are suppressed in other cases: care has been taken that those selected are not culled and put forward on account of any peculiar accordance of the different parts, but that they fairly represent the series of observations.

MAGNETIC DIP AT BALTIMORE, MARYLAND.

The dip at Baltimore was observed by one of us when on a visit to that city in July of the present year. The place of observation was in the front yard of one of the dwellings in Holliday street, opposite to the theatre; the time about 5 P.M. All the circumstances attending the observations were favourable.

The latitude and longitude of Baltimore, as stated in the American Almanac for 1835, are 39° 17′ 13″ N. and 76° 37′ 50″ W.

Needle.	Observed Dip.	Date of Observation.	Observer.	Weather, &c.
No. 1,	70° 56′.5	July 19th.	E. H. Courtenay.	Clear.
No. 2,	70 59 .7	5 P.M.		
No. 2,	70 59 .5			
Mean,	70 58 .6			

MAGNETIC DIP AT PHILADELPHIA, PENNSYLVANIA.

These observations were made upon a marble column in the yard to the south of Professor Bache's dwelling, in Chestnut street near Schuylkill Sixth street. The details of the separate observations are given. The latitude of Philadelphia is 39° 56′ 59″; and the longitude, according to the determination given by Mr S. C. Walker in the fifth volume of the Society's Transactions, is 75° 11′ 31″.

Needle.		Limb.	Needle.	Observed Dip.	Remarks, &c.
No. 1.	Poles direct.	W.	E.	71° 33′	July 25th,
		E.	W.	72 32	1834.
		E.	E.	71 42	About 7 P.M.
		W.	W.	72 13 .5	
	Poles reversed.	W.	W.	71 17	
		E.	E.	72 15 .5	
		E.	W.	71 45 .5	
		W.	E.	72 21	Sum
		Mean 71° 57′.4			575° 39′.5
No. 2.	Poles direct.	W.	W.	71° 36′	Observers,
		E.	E.	72 15 .5	E. H. Courtenay and A. D.
		E.	W.	72 05	Bache.
		W.	E.	71 56 .5	
	Poles reversed.	W.	W.	72 01	
		E.	E.	72 15 .5	
		E.	W.	72 13 .5	
		W.	E.	71 51	
		Mean 72° 01′.7			Sum 576° 14′
Mean by the two Needles 71° 59′.6					

Needle.		Limb.	Needle.	Observed Dip.	Remarks, &c.
No. 1.	Poles direct.	E.	W.	71° 42′	August 4th,
		W.	E.	72 16	1834.
		W.	W.	71 19 .5	Finished at
		E.	E.	72 45	8 P.M.
	Poles reversed.	E.	W.	72 31 .5	Weather clear.
		W.	E.	71 23 .5	(Cumulus.)
		W.	W.	72 16	Wind S. W.
		E.	E.	71 52 .5	Tem. 77° Fah.
		Mean 72° 00′.8			Sum 576° 06′.0
No. 2.	Poles direct.	E.	W.	72° 14′.5	Observer,
		W.	E.	72 01 .5	A. D. Bache.
		W.	W.	71 49	
		E.	E.	72 15	
	Poles reversed.	E.	W.	72 08 .5	
		W.	E.	71 46	
		W.	W.	71 41	
		E.	E.	72 11	Sum
		Mean 72° 00′.8			576° 06′.5
Mean by the two Needles 72° 00′8					

Dip by mean of both Observations 72° 00′.2

MAGNETIC DIP AT NEW YORK.

The dip was observed on the green in front of Columbia College nearly in the position in which the observations of Captain Sabine were made in December 1822. The kindness of Professor Renwick furnished the means of rendering the observations effective, and pointed out the locality where those of Captain Sabine were made.

The latitude of New York, as given by Mr Paine, is 40° 42′ 40″ N. and the longitude 74° 01′ 08″ W.

Needle.	Observed Dip.	Temp.	Date of Observation.	Observer.	Weather.
No. 1, No. 2,	72° 48′.4 72 55 .0	80° Fahr.	August 7, 1834, 9½ A.M.	A. D. Bache.	Clear. Wind N. W.
Mean,	72 51 .7				

The dip observed by Captain Sabine was 73° 00′.5. A comparison of the result just given with this, shows a difference of 8′.8, which, if we were certain that the decrease had been progressive, would indicate a diminution of about nine minutes in the interval of twelve years. This seems, however, from the results obtained at West Point, and next to be given, not to have been the case, observations there, indicating a slight increase from April to July 1834. The decision of this question must be left to future observations.

MAGNETIC DIP AT WEST POINT, NEW YORK.

The greatest number of observations made at any one of the places at which we have observed, were made at West Point, latitude 41° 23′ 35″ N., and longitude 74° 01′ W. The first set of observations was taken under the shelter of a tent, about the middle of the plain on which the buildings of the Military Academy are situated; the others on a brick column, raised for these and similar observations, to the north of the residence of Professor Courtenay.

The following table contains results obtained between the 15th of April 1833, and July 14th, 1834. It seems to indicate a gradual increase in the dip, and although the differences are small, they are, except in the case of the last observation, in the same direction. The observation made in 1833 is not entirely comparable with those in 1834, having been made in a different locality.

No. of Series.	Needle.	Observed Dip. Separate Observs.	Observed Dip. Mean.	Temp. Fahr.	Date of Observations.	Observers.	Place of Observation.
1	No. 1	73° 26′.4			April 15, 1833. 11 A.M. to 3 P.M.	Professors Courtenay and Henry.	Middle of plain.
	No. 2	73 25 .2	73° 25′.8				
2	No. 1	73 35 .1			April 22, 1834. 3 P.M.	E. H. Courtenay & A. D. Bache.	Brick column north of Professor Courtenay's house.
	No. 2	73 35 .3	73 35 .2				
3	No. 1	73 35 .1		81°	May 19, 1834.	E. H. Courtenay & Assistant Professor Cram.	
	No. 2	73 35 .5					
	No. 1	73 37 .3	73 36 .0				
4	No. 1	73 36 .6		65	June 3, 1834.	E. H. Courtenay.	
	No. 2	73 36 .4	73 36 .5				
5	No. 1	73 39 .2		90	July 9, 1834.	E. H. Courtenay.	
	No. 2	73 39 .6	73 39 .4				
6	No. 1	73 38 .7	73 38 .7		July 14, 1834.	E. H. Courtenay.	
Mean of 2, 3, 4, 5, 6 : 73° 37′.2.							

MAGNETIC DIP AT PROVIDENCE, RHODE ISLAND; AND AT SPRINGFIELD MASSACHUSETTS.

The observations at both these places were made under disadvantageous circumstances. Owing to the brief stay which it was possible to make at Providence, the observations were unavoidably made in the evening, and a brisk breeze from the south and south west increased the difficulties incident to that time of the day: but for the kind assistance of President Wayland, and of Professor Caswell, the observations could not have been completed. Needle No. 1 only was observed.

The place of observation was on the green in front of Brown University, and just in rear of the President's house. Latitude 41° 49′ 25″ N. and longitude 71° 25′ 26″ W.

At Springfield no magnet was at hand for reversing the poles of the needle. By comparing, however, the dip observed with needle No. 1

at Providence and Albany with the poles direct and reversed, we find for the former place, that the observed dip with the poles direct fell short of that when they were reversed by 1.9 minute, and for the latter place, that the observed dip with the poles direct exceeded that when they were reversed by 1.7 minute, giving a correction for the eccentricity of the centre of gravity in needle No. 1 of + 0.9 minute. For needle No. 2 the same correction obtained from the New York observations, where the poles were reversed next before the Springfield observations, and from those at Albany, where they were reversed next after the Springfield results, is + 4.3 minutes and + 3.9 minutes, the mean being + 4.1 minutes. The error from not reversing the poles is thus probably reduced to less than one minute.

The place of observation was in the yard attached to the Hamden Coffee-house Hotel. The latitude of Springfield, as stated by Mr Paine, is 42° 05′ 58″ N., and the longitude 72° 36′ W.

Needle.	Dip.	Temp.	Date of Observation.	Place.	Observer.	Weather.
No. 1,	74° 02′.8	68°	August 8, 1834, 10½ P.M.	Providence.	A. D. Bache.	Clear. Wind S. and S. W.
No. 1,	74 01 .1	65	August 10, 1834, 8 A.M.	Springfield.	A. D. Bache.	Cloudy. Wind N. E.
Do. corrected,	74 02 .0					
No. 2,	74 15 .3					
Do. corrected,	74 09 .4					
Mean corrected,	74 10 .7					

MAGNETIC DIP AT ALBANY, NEW YORK.

The observations at this place with the two needles were divided by a severe thunder storm, which however lasted but fifteen minutes. The facilities for observation were perhaps counterbalanced by this circumstance. After due examination of the positions which Professor Henry had occupied for similar observations; the want of a proper shelter, and other circumstances connected with changes made since the date referred to, induced the preference of a station in the lower part of the town, in rear of Foot's hotel.

The latitude of Albany is 42° 39′ 03″ N., longitude 73° 44′ 49″ W.

Needle.	Observed Dip.	Temp.	Date of Observation.	Observer.	Weather.
No. 1,	74° 40′.8	99°	Aug. 11, 1834, 2 P.M.	A. D. Bache.	Cumulus. Sun shines near needle.
No. 2,	74 39 .5	88	Do.	Do.	After a gust.
Mean,	74 40 .1				

The dip, as observed by Professor Henry and Assistant Professor Cram in the Academy Park in April 1833, was 74° 51′.1, exceeding the above by 11′.1.

ARTICLE IX.

Contributions to Electricity and Magnetism. By Joseph Henry, Professor of Natural Philosophy in the College of New Jersey, Princeton, late of the Albany Academy.

No. I.—Description of a Galvanic Battery for producing Electricity of different Intensities. Read before the American Philosophical Society, January 14th, 1835.

The following account of a Galvanic Battery, constructed under my direction for the Physical Department of the College of New Jersey, is submitted to the American Philosophical Society with the intention of referring to it in some communications which I purpose making on the subject of Electricity and Magnetism. It is hoped, however, that the arrangement and details of the instrument, in themselves, will be found to possess some interest, since they have been adopted in most cases after several experiments and much personal labour.

The apparatus is intended to exhibit most of the phenomena of Galvanism and all those of Electro-Magnetism, on a large scale, with one battery. It was constructed to illustrate the several facts of these branches of science to my class, and also to be used as a convenient instrument of research in all cases where no very great degree of intensity is required.

The several parts of this battery are not soldered together forming one permanent galvanic arrangement, but are only temporarily connected by means of movable conductors and cups of mercury. The whole is constructed in reference to the principle well understood of producing electricity of greater or less intensity, by a change in the method of uniting the several elements with each other.

The apparatus consists of eighty-eight elements or pairs, composed of plates of rolled zinc nearly one eighth of an inch thick, nine inches wide, and twelve inches long, inserted into copper cases open at top and bottom. Eleven of these elements are suspended together from two cross pieces of wood, and the whole number is thus arranged in eight sets, of eleven in each. These are supported by the ends of the cross-pieces in a strong wooden frame, so as to be immersed in eight separate troughs: they thus form as many independent batteries, which can be used separately or together as the occasion may require. Each trough is divided into eleven cells by wooden partitions coated with cement. If one of the cells be charged with dilute acid, a single element may be excited without producing action in any other part of the battery. Each set or battery may also be lifted separately from the frame by its cross pieces, without disturbing the other parts of the apparatus.

The elements remain stationary, while the troughs are raised to them on a movable platform by the common application of a wheel and pinion.

The general arrangement of the whole may be seen at once by a reference to the perspective drawing, fig. 1, Plate XXII. *a a*, &c. represent the cross pieces resting on the upper part of the frame of the machine; *c c* is the movable platform.

A perspective view of one of the elements on a larger scale is given in fig. 3. *a a* are two cups of cast copper, with a broad stem on the bottom; one soldered to the zinc plate, and the other to the copper case. The cavity in these cups is about three eighths of an inch wide, a little more than an inch long, and half an inch deep. The cups being well amalgamated and partially filled with mercury, receive the ends of the copper conductors which unite the several elements.

For the purpose of suspension, a slip of copper, *b b*, with a hole in it, is soldered to each upper corner of the copper case; these fit loosely into a mortice or narrow groove in the cross pieces, and are secured by a pin of copper wire. When the pins are withdrawn, a single element may be removed from any part of the series, without disturbing the remainder.

The zinc plate is fastened into its copper case, without touching, by a piece of wood at each corner, with a groove in it to receive the edge of the plate. The grooves in the two lower pieces of wood terminate at about a quarter of an inch from the lower end, and thus form shoulders, which prevent the plate from slipping down; while the wood itself is supported by a flange, formed by bending in the lower edges of the corner of the copper case.

There are two principal sets of connectors; the first is formed of bars of cast copper thirteen inches long, an inch wide, and about an eighth of an inch thick. On the lower side of these are eleven broad projections, which fit loosely into a row of cups on the plates of zinc or copper. Fig. 4 represents one of these connectors with a thimble soldered on the upper side for the purpose of attaching a conductor, which may serve as a pole.

There are two of these for each of the eight batteries, and when in their places, one unites all the zinc, and the other all the copper, so that the battery becomes a calorimotor of a single element or pair. If with this arrangement the several batteries be connected, zinc to zinc and copper to copper, by conductors reaching from one to the other, the whole apparatus of eighty-eight elements becomes a large calorimotor of a single pair; but if the copper of the first be united to the zinc of the second, and so on, it then forms a calorimotor of eight elements, and by a simple change may be reduced to one of four, or of two, elements.

The other set of connectors consists of short pieces of thick copper plate, the ends of which are bent down at right angles, so as to dip into the cups of mercury: they connect the copper of one element with the zinc of the next. Ten of these, intended to unite the elements of one battery, are shown in fig. 5. They are attached crosswise to a slip of harness leather, which, by its pliability, permits them to fit loosely into the cups, while it enables the whole set to be removed as one piece. When these connectors are in their places, and the several batteries united, the copper pole of the one, with the zinc pole of another, and so on, the whole series forms a deflagrator of eighty-eight elements.

The different arrangements of the several connectors will be readily understood by a reference to the plan drawing, fig. 2, which exhibits one half of the whole apparatus arranged as a deflagrator of forty-four elements, and the other half as a calorimotor of four pairs. By closely inspecting the drawing, it will be seen that the connexion in the upper half of the figure is from the copper of the first element to the zinc of the next, and so on through the entire series of forty-four elements. In the lower half the union of copper and zinc takes place only between the poles of the different batteries; the several elements of which are united so as to act as one plate of copper and one of zinc. The four batteries therefore will act together as a calorimotor of four elements. The arrangement, as given in the drawing, is intended to illustrate by one figure the two sets of connectors; but such an arrangement becomes interesting in practice in determining the effect of the conjoined actions of batteries producing electricity of different intensities.

The circuit of the connexions as given in the figure is complete except at *a b*; the two plates at this point form the poles of the battery. A set of poles, however, may be formed at any other point of the circuit, by making an interruption at that place. In the same way two or more sets may be formed. It furnishes an interesting and instructive experiment to place a pair of large decomposing plates at *a b* and another at *c d*. When only one of these is plunged into a saline solution, the circuit being interrupted at the other pair, no effect is produced; but as soon as this other is plunged into a similar solution, a copious decomposition simultaneously takes place at both. Also the contemporaneous action in each element of the battery is pleasingly shown by placing at the same time several large magnetic needles on the different parts of the apparatus. These instantly change their direction when the second pair of decomposing plates touch the solution.

At first sight it might be supposed that there would be some difficulty in entering the several plates into their respective cells, but this is obviated by the precise movement of the platform on which the troughs stand. Its horizontal position is adjusted by four screws (*c c* fig. 1), and its corners slide in grooves in the upright posts of the large frame. Besides this, when the plates are once entered, they are not required to be entirely withdrawn from the cells until the end of the series of experiments; since the acid descends as the plates are withdrawn, and finally fills but little more than three-fourths of the capacity of the cells. When a plate accidentally catches on the side of the cell, the battery to which it belongs is gently raised in its place and the plate adjusted.

This apparatus readily furnishes the means of making comparative experiments on the difference produced by partial and perfect insulation. When no higher degree of intensity is required than that afforded by eight pairs of plates, perfect insulation is obtained by the eight separate troughs. In higher degrees of intensity the partitions in the troughs furnish the means of perfectly insulating forty-eight of the elements: this is effected by simply charging with acid every other cell in each of the troughs, and connecting the corresponding element by conductors, which pass over the intermediate elements without touching them: with this arrangement we have six cells in each trough separated from one another by a cell without acid, or in effect by a stratum of air. For comparison with these a set of troughs has been constructed without partitions.

The want of perfect insulation is not very perceptible in the common experiments of the deflagration of large and perfect conductors; but where the decomposition of a liquid is attempted, or the battery required to act on a small or imperfect conductor, the loss of power is very great, the apparatus partially discharging itself through its own liquid, and the intensity at the poles does not increase with a short interruption of the current.

There is also considerable loss on account of imperfect insulation even in the case of low intensity, and when the poles are connected by a perfect conductor. In one experiment with an arrangement of five pairs, and the poles united by a conductor composed of thirty strands of copper bell wire, each forty feet long, the loss was found to be at least one seventh, as measured by the quantity of zinc surface required to be immersed in order to produce the same magnetic effect. I would infer from this that the most perfect of all Dr Hare's ingenious galvanic arrangements is that in which the elements dip into separate glass vessels, as this combines perfect insulation with the power of instantaneous immersion.

A variety of experiments have been made during the past year with this instrument on several points of Galvanism and Electro-Magnetism, which will be communicated to the society as soon as my engagements will permit me to repeat and arrange them for publication.

ARTICLE X.

Contributions to Electricity and Magnetism. By Joseph Henry, Professor of Natural Philosophy in the College of New Jersey, Princeton, late of the Albany Academy.

No. II.—On the Influence of a Spiral Conductor in increasing the Intensity of Electricity from a Galvanic Arrangement of a Single Pair, &c. Read before the American Philosophical Society, February 6th, 1835.

In the American Journal of Science for July 1832, I announced a fact in Galvanism which I believe had never before been published. The same fact, however, appears to have been since observed by Mr Faraday, and has lately been noticed by him in the November number of the London and Edinburgh Journal of Science for 1834.

The phenomenon as described by me is as follows. "When a small battery is moderately excited by diluted acid, and its poles, terminated by cups of mercury, are connected by a copper wire not more than a foot in length, no spark is perceived when the connection is either formed or broken; but if a wire thirty or forty feet long be used instead of the short wire, though no spark will be perceptible when the connection is made, yet when it is broken by drawing one end of the wire from its cup of mercury, a vivid spark is produced. If the action of the battery be very intense, a spark will be given by a short wire; in this case it is only necessary to wait a few minutes until the action partially subsides, or no more sparks are given; if the long wire be now substituted, a spark will again be obtained. The effect appears somewhat increased by coiling the wire into a helix; it seems also to depend in some measure on the length and thickness of the wire. I can account for these phenomena only by supposing the long wire to become charged with electricity, which, by its reaction on itself, projects a spark when the connection is broken."*

The above was published immediately before my removal from Albany to Princeton, and new duties interrupted, for a time, the further prosecution of the subject. I have, however, been able during the past year to resume in part my investigations, and among others, have made a number of observations and experiments which develope some new circumstances in reference to this curious phenomenon.

These, though not as complete as I could wish, are now presented to the Society, with the belief that they will be interesting at this time on account of the recent publication of Mr Faraday on the same subject.

The experiments are not given in the precise order in which they were first made, but in that which I deem best suited to render them easily understood; they have, however, been repeated for publication in almost the same order in which they are here given.

1. A galvanic battery, consisting of a single plate of zinc and copper, and exposing one and a half square feet of zinc surface, including both sides of the plate, was excited with diluted sulphuric acid, and then permitted to stand until the intensity of the action became nearly constant. The poles connected by a piece of copper bell wire of the ordinary size and five inches long, gave no spark when the contact was broken.

2. A long portion of wire, from the same piece with that used in the last experiment, was divided into equal lengths of fifteen feet, by making a loop at each division, which could be inserted into the cups of mercury on the poles of the battery. These loops being amalgamated and dipped in succession into one of the cups while the first end of the

* Silliman's Journal, vol. 22, page 408.

wire constantly remained in the other, the effect was noted. The first length, or fifteen feet, gave a very feeble spark, which was scarcely perceptible. The second, or thirty feet, produced a spark a little more intense, and the effect constantly increased with each additional length until one hundred and twenty feet were used; beyond this there was no perceptible increase; and a wire of two hundred and forty feet gave a spark of rather less intensity. From other observations I infer, that the length necessary to produce a maximum result, varies with the intensity of the action of the battery, and also with its size.

3. With equal lengths of copper wire of unequal diameters, the effect was greater with the larger: this also appears to depend in some degree on the size of the battery.

4. A length of about forty feet of the wire used in experiments first and second, was covered with silk and coiled into a cylindrical helix of about two inches in height and the same in diameter. This gave a more intense spark than the same wire when uncoiled.

5. A ribbon of sheet copper nearly an inch wide and twenty-eight and a half feet long, was covered with silk, and rolled into a flat spiral similar to the form in which woollen binding is found in commerce. With this a vivid spark was produced, accompanied by a loud snap. The same ribbon uncoiled gave a feeble spark, similar in intensity to that produced by the wire in experiment third. When coiled again the snap was produced as at first. This was repeated many times in succession, and always with the same result.

6. To test still farther the influence of coiling, a second ribbon was procured precisely similar in length and in all other respects to the one used in the last experiment. The effect was noted with one of these coiled into a flat spiral and the other uncoiled, and again with the first uncoiled and the second coiled. When uncoiled, each gave a feeble spark of apparently equal intensity; when coiled, a loud snap. One of these ribbons was next doubled into two equal strands, and then rolled into a double spiral with the point of doubling at the centre. By this arrangement the electricity, in passing through the spiral, would move in opposite directions in each contiguous spire, and it was supposed that in this case the opposite actions which might be produced would neutralize each other. The result was in accordance with the anticipation:

the double spiral gave no spark whatever, while the other ribbon coiled into a single spiral produced as before a loud snap. Lest the effect might be due to some accidental touching of the different spires, the double spiral was covered with an additional coating of silk, and also the other ribbon was coiled in the same manner; the effect with both was the same.

7. In order to increase if possible the intensity of the spark while the battery remained the same, larger spirals were applied in succession. The effect was increased until one of ninety-six feet long, an inch and a half wide and weighing fifteen pounds, was used. The snap from this was so loud that it could be distinctly heard in an adjoining room with the intervening door closed. Want of materials has prevented me from trying a larger spiral conductor than this, but it is probable that there is a length which, with a given quantity and intensity of galvanism would produce a maximum effect. When the size of the battery is increased, a much greater effect is produced with the same spiral. Thus when the galvanic apparatus described in the first article is arranged as a calorimotor of eight pairs, the snap produced on breaking contact with the spiral last described, resembled the discharge of a small Leyden jar highly charged.

8. A handle of thick copper was soldered on each end of the large spiral at right angles to the ribbon, similar to those attached to the wires in Pixii's magneto-electric machine for giving shocks. When one of these was grasped by each hand and the contact broken, a shock was received which was felt at the elbows, and this was repeated as often as the contact was broken. This shock is rather a singular phenomenon, since it appears to be produced by a lateral discharge, and it is therefore important to determine its direction in reference to the primary current.

A shock is also received when the copper of the battery is grasped by one hand, and the handle attached to the copper pole of the ribbon with the other. This may be called the direct shock, since it is produced by a part of the direct current. It is, however, far less intense than that produced by the lateral discharge.

10. When the poles were joined by two coils connected by a cup of mercury between them, a spark was produced by breaking the circuit

at the middle point, and when a pair of platina wires was introduced into the circuit with the large coil and immersed in a solution of acid, decomposition took place in the liquid at each rupture of contact, as was shown by a bubble of gas given off at each wire. It must be recollected that the shocks and the decomposition here described were produced by the electricity from a single pair of plates.

11. The contact with the poles of the battery and the large spiral being broken in a vessel containing a mixture of hydrogen and atmospheric air, an explosion was produced.

I should also mention that the spark is generally attended with a deflagration of the mercury, and that when the end of the spiral is brought in contact with the edge of the copper cup or the plate of the battery, a vivid deflagration of the metal takes place. The sides of the cup sometimes give a spark when none can be drawn from the surface of the mercury. This circumstance requires to be guarded against when experimenting on the comparative intensities of sparks from different arrangements. If the battery formerly described (fig. 1, Plate XII.) be arranged as a calorimotor, and one end of a large spiral conductor be attached to one pole, and the other end drawn along the edge of the connector, fig. 4, a series of loud and rapid explosions is produced, accompanied by a brilliant deflagration of the metal, and this takes place when the excitement of the battery is too feeble to heat to redness a small platina wire.

12. A number of experiments were made to determine the effect of introducing a cylinder of soft iron into the axis of the flat spiral, in reference to the shock, the spark, &c., but no difference could be observed with the large spiral conductor. The effect of the iron was merged in that of the spiral. When, however, one of the smaller ribbons was formed into a hollow cylindrical helix of about nine inches long, and a cylinder of soft iron an inch and a half in diameter was inserted, the spark appeared a little more intense than without the iron. The obliquity of the spires in this case was unfavourable to their mutual action, while the magnetism was greater than with the flat spiral, since the conductor closely surrounded the whole length of the cylinder.

I would infer, from these experiments, that some effects heretofore attributed to magneto-electric action are chiefly due to the reaction on each other of the several spires of the coil which surround the magnet.

13. One of the most singular results in this investigation was first obtained in operating with the large galvanic battery (fig. 2, Plate XXII.). The whole instrument was arranged as a calorimotor of eight pairs, and a large spiral conductor introduced into the circuit at *c d*, while a piece of thick copper wire about five inches long united the poles at *a b*. In this state an explosion or loud snap was produced, not only when the contact was broken at the spiral, but also when one end of the short wire at the other extremity of the apparatus was drawn from its cup. All the other short movable connectors of the battery gave a similar result. When the spiral was removed from the circuit and a short wire substituted, no effect of the kind was produced. From this experiment it appears that the influence of the spiral is exerted through at least eight alternations of zinc, acid and copper, and thus gives to a short wire at the other extremity of the circuit the power of producing a spark.

14. The influence of the coil was likewise manifest when the zinc and copper plates of a single pair were separated from each other to the distance of fourteen inches in a trough without partitions, filled with diluted acid. Although the electrical intensity in this case must have been very low, yet there was but little reduction in the apparent intensity of the spark.

15. The spiral conductor produces, however, little or no increase of effect when introduced into a galvanic circuit of considerable intensity. Thus when the large spiral used in experiment seventh, eighth, &c. was made to connect the poles of two Cruikshank's troughs, each containing fifty-six four inch plates, no greater effect was perceived than with a short thick wire: in both cases in making the contact a feeble spark was given, attended with a slight deflagration of the mercury. The batteries at the same time were in sufficiently intense action to give a disagreeable shock. It is probable, however, that if the length of the coil were increased in some proportion to the increase of intensity, an increased effect would still be produced.

In operating with the apparatus described in the last experiment, a phenomenon was observed in reference to the action of the battery itself, which I do not recollect to have seen mentioned, although it is intimately connected with the facts of Magneto-Electricity, as well as with the subject of these investigations, viz. When the body is made to form a part of a galvanic circuit composed of a number of elements, a shock is, of course, felt at the moment of completing the circuit. If the battery be not very large, little or no effect will be perceived during the uninterrupted circulation of the galvanic current; but if the circuit be interrupted by breaking the contact at any point, a shock will be felt at the moment, nearly as intense as that given when the contact was first formed. The secondary shock is rendered more evident, when the battery is in feeble action, by placing in the mouth the end of one of the wires connected with the poles; a shock and flash of light will be perceived when the circuit is completed, and also the same when the contact is broken at any point, but nothing of the kind will be perceived in the intermediate time, although the circuit may continue uninterrupted for some minutes. This I consider an important fact in reference to the action of the voltaic current.

The phenomena described in this paper appear to be intimately connected with those of Magneto-Electricity, and this opinion I advanced with the announcement of the first fact of these researches in the American Journal of Science. They may, I conceive, be all referred to that species of dynamical *Induction* discovered by Mr Faraday, which produces the following phenomenon, namely: when two wires, A and B, are placed side by side, but not in contact, and a voltaic current is passed through A, there is a current produced in B, but in an opposite direction. The current in B exists only for an instant, although the current in A may be indefinitely continued; but if the current in A be stopped, there is produced in B a second current, in an opposite direction however to the first current.

The above fundamental fact in Magneto-Electricity appears to me to be a direct consequence of the statical principles of "Electrical *Induction*" as mathematically investigated by Cavendish, Poisson and others. When the two wires A and B are in their natural state, an equilibrium is sustained by the attractions and repulsions of the two fluids in each wire; or, according to the theory of Franklin and Cavendish, by the attractions and repulsions of the one fluid, and the matter of the two wires. If a current of free electricity be passed through A, the natural equilibrium of B will be disturbed for an instant, in a similar manner to the disturbance of the equilibrium in an insulated conductor, by the sudden addition of fluid to a contiguous conductor. On account of the repulsive action of the fluid, the current in B will have an opposite direction to that in A; and if the intensity of action remains constant, a new state of equilibrium will be assumed. The second state, however, of B may perhaps be regarded as one of tension, and as soon as the extra action ceases in it, the fluid in B will resume its natural state of distribution, and thus a returning current for an instant be produced.

The action of the spiral conductor in producing sparks, is but another case of the same action; for since action and reaction are equal and in contrary directions, if a current established in A produces a current in an opposite direction in B, then a current transmitted through B should accelerate or increase the intensity of a current already existing in the same direction in A. In this way the current in the several successive spires of the coil may be conceived to accelerate, or to tend to accelerate each other; and when the contact is broken, the fluid of the first spire is projected from it with intensity by the repulsive action of the fluid in all the succeeding spires.

In the case of the double spiral conductor, in experiment sixth, the fluid is passing in an opposite direction; and according to the same views, a retardation or decrease of intensity should take place.

The phenomenon of the secondary shock with the battery, appears to me to be a consequence of the law of Mr Faraday. The parts of the human body contiguous to those through which the principal current is passing, may be considered as in the state of the second wire B; when the principal current ceases, a shock is produced by the returning current of the natural electricity of the body.

If this explanation be correct, the same principle will readily account for a curious phenomenon discovered several years since by Savary, but which I believe still remains an isolated fact. When a current is transmitted through a wire, and a number of small needles are placed transverse to it, but at different distances, the direction of the magnetic polarity of the needles varies with their distance from the conducting wire. The action is also periodical; diminishing as the distance increases, until it becomes zero; the polarity of the needles is then inverted, acquires a maximum, decreases to zero again, and then resumes the first polarity; several alternations of this kind being observed.* Now this is precisely what would take place if we suppose that the principal current induces a secondary one in an opposite direction in the air surrounding the conductor, and this again another in an opposite direction at a great distance, and so on. The needles at different distances would be acted on by the different currents, and thus the phenomena described be produced.

The action of the spiral is also probably connected with the fact in common electricity called the lateral discharge: and likewise with an appearance discovered some years since by Nobili, of a vivid light, produced when a Leyden jar is discharged through a flat spiral.

The foregoing views are not presumed to be given as exhibiting the actual operation of nature in producing the phenomena described, but rather as the hypotheses which have served as the basis of my investigations, and which may farther serve as formulæ from which to deduce new consequences to be established or disproved by experiment.

Many points of this subject are involved in an obscurity which requires more precise and extended investigation; we may, however, confidently anticipate much additional light from the promised publication of Mr Faraday's late researches in this branch of science.

* Cummings's Demonferrande, page 247; also Edinburgh Journal, October 1826.

ARTICLE XI.

Collection of Observations on the Solar Eclipse of November 30*th*, 1834, *made at Philadelphia, Haverford, West-Hills, Baltimore, the University of Virginia, Norfolk, Cincinnati and Nashville. Reported March* 6*th*, 1835.

The Committee appointed to make a collection of Observations on the recent Solar Eclipse, respectfully report the following for publication in the Transactions of the Society.

Alex. Dallas Bache.
Jos. Roberts, Jun.
Isaiah Lukens.

Memorandum of Observations of the Solar Eclipse of November 30*th*, 1834, *made at the University of Pennsylvania. By Edward H. Courtenay, Professor of Mathematics in the University of Pennsylvania.*

During one or two hours immediately preceding the commencement of the eclipse, the sun was frequently obscured by clouds; but these, although not entirely dispersed, had disappeared sufficiently to permit a very satisfactory observation of the commencement. For several seconds (say five or six) previous to the first distinct impression on the sun's disk, a slight tremulous motion was distinctly observed near that point of the limb at which the eclipse was expected to commence. This served as an additional guide to the eye, which was accordingly found to be directed very accurately to the point at which the indentation first occurred. The limb of the sun at this time was beautifully defined; soon after the commencement, the clouds began again to accumulate, and at the period of greatest obscuration the sun was entirely concealed. About twenty minutes before the end the clouds had again dispersed, leaving the sun much brighter than at any previous period during the eclipse, and giving promise of a highly satisfactory observation of the end; but at fifteen or twenty seconds before the final separation of the disks a light fleecy cloud passed before them, alternately concealing the sun and permitting him to be seen. The effect of this was to dazzle the eye, and to render the vision so far imperfect that the instant of separation of the disks could not be fixed as satisfactorily as that of the commencement. The observations were made with a sixty inch refractor by Dollond belonging to the University of Pennsylvania, the diameter of the object glass being three and three-fourths inches. The time keeper was a chronometer of excellent character by Parkinson and Frodsham, and its error and rate were ascertained by frequent transits of the sun and stars on the day of the eclipse and for several days previous. The limbs of the sun and moon, when not obscured by clouds, were defined as distinctly as could have been desired. The colour of the sun's disk, as seen through the dark glass used, was a bright orange extremely agreeable to the eye; that of the moon intensely black.

The times observed, reduced to the meridian of Independence Hall, were as follows:

	h.	m.	sec.
Commencement,	1	00	10.5
End,	3	37	51.5
Duration,	2	37	41

Observations of the temperature were likewise made with two thermometers by Pastorelli (the bulb being uncoated); the one exposed to the sun's rays on the south side of the university, the other well sheltered from the sun and having a north western exposure. The sudden and frequent fluctuations of the thermometer in the sun are attributable to the frequent interposition of clouds.

Hour.	Therm. in Sun.	Therm. in Shade.	
10 15 A.M.	64	44	Very clear. Wind N. W.
10 30 A.M.	64	46	Very clear. Wind N. W.
11 00 A.M.	70	46	Very clear. Wind N. W.
11 30 A.M.	63	47	Thin white clouds.
12 00 M.	59	47	Sun shining through clouds.
12 30 P.M.	54	47	Clouds thicker.
12 45 P.M.	64	48	Sun quite bright.
12 55 P.M.	66	48	Sun quite bright. } Commencement of Eclipse.
1 05 P.M.	68	48	Sun quite bright. } Commencement of Eclipse.
1 15 P.M.	58	48	Sun considerably obscured.
1 30 P.M.	55	48	Sun considerably obscured.
1 45 P.M.	52	47	Sun nearly invisible.
2 00 P.M.	50	47	Sun just visible.
2 10 P.M.	48	46½	Sun entirely gone.
2 20 P.M.	48	46	Sun entirely gone. Greatest obscuration.
2 30 P.M.	48	46	Clouds thinner. Sun can be seen.
2 40 P.M.	48	46	Sun continues to grow brighter.
2 50 P.M.	48½	46	Sun quite bright.
3 00 P.M.	48½	45½	Sun quite bright.
3 15 P.M.	48½	45½	Sun quite bright.
3 30 P.M.	54	46	Sun very bright.
3 45 P.M.	50	46	Sun very bright.

Observations of a hollow magnetic needle (by Lukens) suspended horizontally by silk fibres, and placed in one of the west windows of the University.

Hour.	Division indicated by South Pole.	Hour.	Division indicated by South Pole.
11 00 A.M.	25′ W.	2 10 P.M.	24′ W.
11 30 A.M.	27 W.	2 20 P.M.	23 W.
12 00 M.	30 W.	2 40 P.M.	23 W.
12 30 P.M.	28 W.	2 50 P.M.	23 W.
12 45 P.M.	28 W.	3 00 P.M.	24 W.
1 15 P.M.	29 W.	3 15 P.M.	24 W.
1 30 P.M.	30 W.	3 30 P.M.	26 W.
1 45 P.M.	29 W.	3 45 P.M.	24 W.
2 00 P.M.	25 W.		

The divisions pointed out by the needle indicate nothing as to the *actual amount of the magnetic variation,* but simply the change in variation during the eclipse.

Observations on the Eclipse of the Sun November 30th, 1834, made at Friends' Observatory, Fourth Street, Philadelphia. By Joseph Roberts, Jun.

The morning was clear and without clouds till about eleven o'clock, when the eastern, western and southern sky became overcast with thin white clouds moving from the west. At noon determined the state of the clock by the fixed transit instrument. The beginning of the eclipse, observed with an achromatic telescope with a power of about 38, happened at 1 h. 0 m. 15.85 sec. mean civil time, corrected for the rate of the clock, determined by transits both before and after the eclipse. The observation of the beginning was very good; but from a few minutes after the beginning till some time after the end of the eclipse there was a constant succession of clouds between the sun and the observer, often so dense as to render the sun invisible; at the time of the greatest obscuration the sun was visible through thin clouds. Determined the magnitude of the eclipse when compared with a measure of the sun's diameter, taken with a Troughton micrometer near noon of the same day. The obscured part measured 10.755 digits, which differs from the calculation about a three hundredth part of a digit, or five seconds. This observation was made under unfavourable circumstances. The end of the eclipse happened at 3 h. 37 m. 45 sec. mean time corrected. A haze about the sun may have caused the disappearance of the moon a few seconds before the actual end of the eclipse, in which case the latter number should be increased a few seconds.

Observations on the Solar Eclipse of November 30th, 1834, made at Philadelphia and Germantown, Pennsylvania. Communicated by S. C. Walker.

The following observations of the Solar Eclipse of November 30th have been communicated to me by the respective observers. They are all expressed in mean solar time of the Hall of Independence, longitude 5 h. 0 m. 43.9 sec., latitude 39° 56′ 59″.

Beginning.			End.			Observer.	Place of Observation.
h.	m.	sec.	h.	m.	sec.		
1	0	15.3	3	37	55.3	Wistar.	C. Wistar's House, Germantown.
					54.3	Lukens.	
					58.8	T. M'Euen.	T. M'Euen's House, Philadelphia.
		10.3		38	01.3	C. M'Euen.	
				37	52.9	Young.	Third Street, near South Street.
		14.2			14.4	Espy.	100 south Eighth Street.
		20.0				Riggs.	
		15.8		38	00.2	Walker.	

Observations of the temperature during the eclipse. By T. M'Euen.

Hour.	Therm. Fahr.	Hour.	Therm. Fahr.
1 12	50°.5	2 40	45°.00
1 24	50 .0	2 50	45 .00
1 30	49 .0	2 55	Dew point, 24 .00
1 42	48 .0	3 00	44 .75
1 58	47 .25	3 15	44 .50
2 10	46 .5	3 45	44 .50
2 20	46 .0	3 55	44 .00
2 30	45 .25		

Note of Meteorological Observations made during the Solar Eclipse of November 30th, 1834. *By A. D. Bache, Professor of Natural Philosophy and Chemistry in the University of Pennsylvania.*

The day of the eclipse was one of a series of days above the ordinary temperature of the season; a thermometer which on Thursday the 4th of December stood in the shade at 2 P.M. at $35\frac{1}{2}°$ Fahrenheit, stood in the same place on November 28th at 51°, at the same time on the 29th at 48°, on the 1st of December at 51°, on the 2d at 47°, and on the day of the eclipse at $45\frac{1}{4}°$. During the eclipse the thermometer in the shade fell from 49° at 1 o'clock to $43\frac{1}{2}°$ at 2 h. 22 m., the temperature being obtained by swinging the thermometer. On the following day, which was cloudy, the clouds being however less dense than on the 30th, the thermometer rose during the same time $2\frac{1}{2}°$; and on the 28th, at which time there were fewer clouds, $2\frac{3}{4}°$. The effect of the clouds in preventing the rise of the thermometer being taken at $\frac{3}{4}$ of a degree, gives, in addition to a rise of 2° prevented, a depression of $5\frac{1}{2}°$ produced, making $7\frac{1}{2}°$ for the effect on the air. In the eclipse of 1831 the observed effect on the temperature of the air, not taking into account the rise which would in other circumstances have been produced, was $4\frac{3}{4}°$ Fahrenheit, which was, however, much more felt than the present, the fall being from $35\frac{1}{2}°$ Fahrenheit to $30\frac{3}{4}°$.

A thermometer with the bulb blackened by writing ink, and confined in a plate glass case, fell from 101°, at which it stood at 1 P.M., to 46° at 2 h. 30 m., which was the lowest point that it attained, the depression amounting to 55° in one hour and a half, from the effect of the clouds and of the eclipse. In the eclipse of 1831 the depression of a similar instrument not protected from the air was 36°. The variable effect of the temperature of the air renders such comparisons very vague.

The time of greatest obscuration from clouds coincided nearly with that from the eclipse, and the varying density of the clouds rendered the photometer of no service, and disappointed me in observations which had been arranged for that instrument. The photometer, which in 1831 exhibited at the time of greatest obscuration a quantity of light from the direct action of the sun amounting to 4° in 56.5, or $\frac{1}{14}$, gave but 2 for the same quantity on the present occasion. This remark applies only to the direct light, for that which was reflected was greater than in 1831. The dew point, which at 7 A.M. was at 28°, fell, on the formation of clouds, and was at 1 h. 40 m. 24°, and at 2 h. 40 m. $23\frac{1}{2}°$.

A series of magnetic observations on the dip, intensity and variation were made, and the results will at a future date be communicated. They may have an important bearing on the theory of the diurnal variation.

Observations of the times of beginning and end of the Eclipse of the Sun, 11*th month* 30*th,* 1834, *made at Haverford School, Latitude* 40° 1′ 12″ *North. By J. Gummere, Professor of Natural Philosophy and Mathematics.*

	h.	m.	sec.
Beginning,	0	59	12
End,	3	36	53

The state and rate of the clock were determined by a number of observations of the sun's meridian passage, including one on the day of the eclipse: the state of the transit instrument, a twenty inch one by Dollond, being carefully examined by observed transits of high and low stars. The observations of the eclipse were made with a forty-six inch achromatic by Tully and Sons, just received. It has four astronomical eye pieces, but was not accompanied by a statement of their powers, and I have not yet had leisure to ascertain them. The lowest was used; it is probably about forty. At the time of commencement part of a small cloud, too dense to admit of distinct vision through it, obscured the sun for a few seconds, in consequence of which the time of beginning, as given above, may be in error to the amount of three or four seconds. The observation of the end was free from obstruction, and is, I think, accurate. The latitude of our place may be regarded as a near approximation. I have not yet made a sufficient number of observations to consider it accurately determined.

Observations on the Solar Eclipse of November 30*th* 1834, *made at West-Hills, Long Island. By F. R. Hassler, Esq. Communicated by Mr John A. Dahlgren, of the United States Navy.*

By direction of Mr Hassler the following observations of the late solar eclipse, made by him at West-Hills, Long Island, 30th November 1834, are communicated.

	h.	m.	sec.
First contact,	1	09	53.93 mean time,
Last contact,	3	45	18.65 mean time,

Latitude, 40° 48′ 47″.82 N.

Assumed longitude, 4 h. 53 m. 52.7 sec. W.

The station is one of the principal points of the triangulation selected by Mr Hassler for the coast survey.

Observations were made on the day of the eclipse, by order of Mr Hassler, to determine the rate and error of the chronometers and astronomical clock. The apparent time was deduced from the sun's Z. D. in series of ten repetitions, each measured by the repeating circle.

Altitudes were also measured with a reflecting circle of double repetition on Mr Hassler's principle: but as one of the sets was interrupted by the tremor of the mercury from the motion of some of the spectators, the series was rendered imperfect, and could not therefore be used. The latitude was determined by two series on the sun, and seven on α Ursæ Minoris, being all the weather admitted of during the month of November.

Observations of the Solar Eclipse of November 30th, 1834, *made at Baltimore. By Lewis Brantz.*

The place of observation is about one mile west from Monument Square. The latitude being 39° 17′ 12″ W. The time was observed minutely by a chronometer of Parkinson and Frodsham, whose rate has for some time back been 0″.5 slow, and the local mean time was ascertained by sets of altitudes of the sun, accurately observed on the forenoons immediately preceding and succeeding the eclipse.

The contacts were observed by a Dollond's achromatic telescope with a power of eighty-five, assisted by a lesser one of about thirty. The two observations agreed so nearly as not to admit of any distinction.

	h.	m.	sec.	
Beginning,	12	51	58	mean time at Baltimore,
End,	3	31	29½	do. do.

The temperature by a thermometer exposed to the sun, and by another in a northern exposure, was as follows:

	Therm. in Sun.	Therm. to North.
12 M.	66° Fahr.	50° Fahr.
1 P.M.	66	51
2 P.M.	55	49
3 P.M.	62	50

Times of beginning and end of the Solar Eclipse of November 30th, 1834, observed at the University of Virginia. By R. M. Patterson, Professor of Natural Philosophy in the University of Virginia.

	h.	m.	sec.
Commencement,	0	41	11
End,	3	23	43

In 1831 the thermometer in the sun was at 33° Fahrenheit in the middle of the eclipse, and at 51° at the end. On this occasion it was at 54½° to 57° at the middle, 70° to 76° at the beginning, and at 66° at the end; two different thermometers being noted. The thermometer in the shade varied only a degree and a half.

Register of Observations made at Norfolk, Virginia. By Captain A. Talcott, of Corps of Engineers. Latitude of station 36° 51′ 10″. November 30th, 1834.

Time by pocket chron. h.	m.	sec.		Alt. of sun with 18 inch repeating circle.		
8	32	08.5	⌢*	A	0 0 0″	
	33	06	⌢	B	2	
	34	02	⌢	C	5	
Reversed				D	0	Barom. 30.3
	35	44	⌢	A	146° 09′ 20″	Therm. 48°
	36	42	⌢	B	9 45	
	37	39	⌢	C	9 45	
				D	9 25	

* ⌢ Sun's upper limb; ⌣ Sun's lower limb.

Again,

h.	m.	sec.			
8	43	03.5 ⌢	A, B, C and D same as preceding.		
	44	02 ⌢			
	45	00 ⌢			
Reversed					
	48	11 ⌣	A	289° 37′ 30″	
	Lost	⌣	B	05	Barom. 30.3
	50	10 ⌣	C	00	Therm. 48°
			D	10	

After measuring the foregoing altitudes of the sun, the level was clamped, and the following observations for equal altitudes made.

h.	m.	sec.		h.	m.	sec.	
8	57	54 A.M. ⌢	Barom. 30.29	2	27	42.4 P.M. ⌢	Barom. 30.32
	58	57 A.M. ⌢	Therm. 48°		26	40 P.M. ⌢	Therm. 50°
	59	59 A.M. ⌢			25	38	
9	02	07 A.M. ⌣	} The lower limb of the sun was obscured by the moon P.M.				
	03	11 A.M. ⌣					
	04	14 A.M. ⌣					

Time by chron.			Alt. of sun with 18 inch repeating circle.		
h.	m.	sec.			
3	35	06 P.M. ⌣	A	289° 37′ 10″	
	35	56 P.M. ⌣	B	36 30	Barom. 30.34
	36	46 P.M. ⌣	C	36 35	Therm. 48°
Reversed			D	36 50	
	38	10 P.M. ⌢	A	90 26 55	
	39	01.2 P.M. ⌢	B	27 10	
	39	50 P.M. ⌢	C	27 25	
			D	27 05	

Again,

h.	m.	sec.			
3	47	48 P.M. ⌣	A, B, C and D as before.		
	48	38 P.M. ⌣			
	49	26 P.M. ⌣			
Reversed					
	50	56 P.M. ⌢	A	255° 23′ 57″	Barom. 30.34
	51	45.2 P.M. ⌢	B	24 00	Therm. 48°
	52	34 P.M. ⌢	C	23 45	
			D	23 40	

h.	m.	sec.	
0	49	52	Commencement of eclipse.
2	14	00	Greatest obscuration.
3	30	52	End of eclipse.

The v. sine of crescent measured by 257 divisions of micrometer scale, the value of each division being .45191″ or 45″.191 to each thread of the screw.

The foregoing observations for time were made by setting the telescope of the circle, and taking the transit of the sun's first limb, and then reversed. It was thought that the interval, if both limbs were observed, would be too great to allow of taking an arithmetical mean for the time. The second limb was taken after reversing in all but the first morning observation, when the first limb was observed before and after reversing.

To correct, if necessary, any inequality in the rate of the pocket chronometer, in the correctness of which I had little confidence, as it was habitually used as a pocket watch, I compared it about every hour with the clock, which was set going for the occasion. The rate of the clock could be depended upon for uniformity, but what that was, was unknown, as it had been moved in the interval of my absence, and there was no opportunity, owing to the bad weather, of ascertaining the true time or rate until Sunday the day of the eclipse.

Comparison of clock and chronometer:—

	h. m. sec.	h. m. sec.	h. m. sec.	h. m. sec.
Clock,	20 41 00	21 28 00	22 28 00	24 00 00
Chron.	20 22 10.13	21 09 08.13	22 09 05.6	23 41 01.07
Clock,	00 45 00	1 45 00	3 05 00	4 19 00
Chron.	00 25 58.4	1 25 56	2 45 52	3 59 48.5

In addition to the foregoing observations, the following measurements were made of the chord of the obscured segment of the sun with a spider's line micrometer. The telescope to which it was applied was not mounted on the equatorial, and the measurements were not therefore made with as great accuracy as they could have been under more favourable circumstances. They are, however, appended, that they may be examined and used if of any value. The value of the micrometer, as before stated, is .45191″ for each division. By taking a mean of several measurements of the sun's diameter when on or near the meridian, say .452″.

Time by Chronometer.			Div. of Micrometer.	Time by Chronometer.			Div. of Micrometer.
h.	m.	sec.		h.	m.	sec.	
0	52	16.2	1087	3	17	16.3	2516
	53	20	1288		18	08	2451
	54	20.2	1434		19	58.4	2373
	55	12	1530.5		20	36.3	2305
	56	22.3	1701		21	34	2219
	57	56	1844		23	38	1892
	58	36.2	1931		24	22	1827
	59	36.2	2040		25	08	1724
1	00	08.4	2095		25	56	1616
	04	58.4	2489		26	30	1520
	05	42.3	2543		27	08.4	1409
	13	58.4	3064		28	10	1241
	14	44	3102		28	52	1053
3	13	00	2839		29	13	946
	14	16.2	2750		29	42.4	792
	15	30	2647		30	26	502
	16	26	2580				

The following measurements were made of the versed sines of the unobscured part of the sun's disk. The difficulty of measuring these accurately, was much greater than of measuring the chords; in those the perpendicular hair could be made to coincide with the angles of the disk, and there was no doubt of the measured line being perpendicular to the parallel lines of the micrometer. In measuring the versed sines, the eye alone could decide, except so far as it could be aided by first bringing the perpendicular line to coincide with the angular points, and then moving the telescope in azimuth to bring the parallel wires on the concave and convex parts of the crescent; but this line changed its angle with the horizon so rapidly, that little assistance could be derived from this practice.

Time by Chronometer.			Div. of Micrometer.
h.	m.	sec.	
1	17	40	2915
	21	12	2762
	33	18	2150
	39	28	1833
	48	16	1381
	50	28	1263
2	08	48	378
	14	00	257
	20	24	431
	33	02	1050
	41	47	1531
3	06	04	2821
	09	46	3011

Time of beginning and end of Solar Eclipse of November 30th, 1834, observed at Cincinnati, Ohio. By Elisha Dwelle, Surveyor-General's Office, and John Locke, M.D.

	h.	m.	sec.
Observed time of beginning,	0	3	39.7
End,	2	49	39.7

There were a few clouds in the morning, but by eight o'clock they were nearly dissipated, and the weather was in every respect favourable for observation.

The thermometer, in the shade, sunk during the observation from 46° to 44°, but rose afterwards to 48°. Venus was distinctly visible, and Antares and Lyra were seen by some observers.

Observations made on the 30th of November 1834, at Nashville, Tennessee. By James Hamilton, Professor of Natural Philosophy in the Nashville University.

The day was unusually pleasant, and as not a cloud was visible, the opportunities of observation were very favourable. The situation of observation was at the University buildings, about three quarters of a mile east of south from the public square of Nashville, in latitude 36° 9′ 32″.66, as is believed from many very careful trials, and in longitude about 5 h. 47 m. 16 sec. west. The latitude of the square, as determined by circumpolar stars, is about 36° 10′ 7″. The local time was obtained by equal altitudes of the sun, taken by a superior sextant, previously adjusted with much care. The time of the sun's passage through the wires of a transit instrument, not adjusted however precisely to the meridian, but of which the deviation had previously been ascertained, was also noted to obtain the error of the chronometer. The result differed from the former but one-tenth of a second. Unfortunately, in ascertaining the error of the chronometer, the beginning of the eclipse was not observed, but the end was looked for with unremitting vigilance, and occurred at 2 h. 41 m. 45.2 sec.

The telescope used for observation was one of Dollond's refractors; the power used was 50, which was preferred to the 80 or 100, because it gave a much clearer view than these latter.

Venus was seen during one hour and three quarters. Two thermometers, Fahrenheit's scale, were placed in the sun, one of which had the bulb covered with thin blackened paper. Another thermometer was suspended on the north side of a brick building, and was of course in the shade.

Time.	Thermometer in the Sun.		Therm. in Shade.	Barometer.
	Naked bulb.	Blackened bulb.		
h. m.	deg.	deg.	deg.	deg.
11 23	66.5	82.5	47	29.710
33	67	87	47	710
43	69.5	87	47	700
53*	70.5	87	47	695
12 03	72	87	47	670
13	69.5	80	47.5	662
23	66.5	76.5	48	658
33	66.5	75	47.25	650
43	66	72.5	48	640
53	66	71	47	638
1 03	63	64.5	46.25	630
13	59.5	59.5	46	630
23†	56.5	56	45.5	625
33	57	57.5	45	618
43	57.5	59.5	45	610
53	61.5	64.5	46	610
2 03	64	69	46.5	620
13	66.5	69.5	48	620
23	68	73	48	610
33	68	73	48	600
43‡				

It will be seen from these observations that the naked thermometer in the sun continued to rise until ten minutes after the eclipse began, when it stood at 72°. That the blackened thermometer had then risen to 87°, and that at the greatest obscuration both had fallen to nearly the same degree; the naked thermometer to 56.5° through 15.5°,

* Eclipse begins. † Greatest obscuration. ‡ Eclipse had ended.

blackened to 56° through 31°. The thermometer in the shade fell only two degrees, from 47° to 45°. The changes of the thermometer in the shade, as well as of the barometer, present some anomalies, no doubt caused in both by the sudden diminution of heat. The descent of the mercury in the barometer generally continues with much uniformity until about three o'clock, when it reaches the minimum position. On this occasion it rose a little about two o'clock, and after twenty minutes fell again. At twenty minutes past one o'clock a lens one foot in diameter, whose principal focal length is two feet, was not able to collect sufficient rays to burn blackened paper, though perfectly dry; but when brought to bear upon the bulb of a thermometer for two minutes, caused a rise from 54° to 57°.

ARTICLE XII.

De Linguâ Othomitorum Dissertatio; Auctore Emmanuele Naxera, Mexicano, Academiæ Litterariæ Zacatecarum Socio. Communicated to the American Philosophical Society, 6th March 1835.

Pars Prima.

Intuenti mihi, viri gravissimi, antiquæ Mexici victas Divinitates, et quas natura, benigno sub quo primam ego lucem vidi cœlo, liberali manu donavit divitias, vestrâ hâc domû, à vestro nimis noto ergà antiqua nationum monumenta studio collectas, pulcherrimoque ordine compositas, atque ibi illius *quæ Anahuac fuit*, mihi spolia contemplanti, ità vivida dulcis patriæ subiit imago, ut me in ejus sinu potiùs, quam ab eâ exulem, inter pristinas Mexici Pænates, magnâ cum voluptate, esse credebam. Meos antè oculos tunc temporis, magnificentissimum Tenoxtitlanis templum ab impiâ pietate, cujus nescio, sed cultissimi tamen veterisque populi arte constructum: Cholulæ columna, multis ab hinc sæculis, ut, jàm oblitæ rei, à natione nunc etiam oblitâ, memoria numquam periret, ædificata: Popocatepec, albo nivis linteo, quasi chlamyde coopertus, venerabile mari terræque caput demonstrans: horti, depictis floribus ridentes, à lasciviantibus auris suavitèr impulsi, statimque repulsi, hinc illincque aquis, ut Veneris olim filiæ, supernatantes: horridum, lato ore, ignem cineresque evomens, quibus nescio iris, Xurullum: Mexicus, mea illa vitâ charior Mexicus, lacûbus, canalibusque circumdata: ipsi illi lacus, et canales innumeris cymbis, à puellis Indianis, nigro capillo, et nigris oculis pulcherrimis, super fructuûm olerumque throno sedentibus, suavi voce, et suaviori linguâ, hæreditate ab earum avis receptâ, antiquas historias, virginales amores, et Mexici antiqui fata canentibus, lamentantibusque, remigio gubernatis, arati: sacra robora, Hircaniis ætate paria, Tenoxtitlanis civitatem, ut vigiles ac custodes, circumcingentia: Chapultepeci mons, cujus in nemore, nihil aliud nisi passerum modulamen, ac rivorum triste murmur, antiquorum regum, quorum ibi silentia oblitaque sepulchra jacent, manes perturbat, ex aquis apparentem urbem contemplatur: urbs, denique, Mexicus illa, ubi adhùc Moctecuzomæ regali veste, regali visu, regali majestate conspicui circùm augusta umbra vagat; ubi Cortesii strenui, reges debellantis, nationes antiquas expugnantis, gravis, virilisque aspectus, et nunc videri, videtur; ubi miserrimi, non tamen lugendi sed admirandi Guatemozii, ex equuleo, ejus à secretis viro calamitosum eorum casum ipsiusque dolores, ingentibus clamoribus lamentanti, dicentis, "Numquid et ego in rosarum lecto occubo?" vox Romano digna, auditur: ubi tandem et quia victor et quia victus, Hispane Leo, rugire tu audire: tuque, Mexicana Aquila, mea dulcis mater, et victa et victrix, tuos sub alis filios congregas ac foves; ubi eò undè venerunt, tot gubernatorum imperia, quot, paucis annis, apparuerunt, repentè arrepta rediisse videmus. En quæ meos ante oculos, cumulatim prætereunt. Qui non tunc Mexicani cordis sensus? quos animus motus non experietur? Nam optimè ille philosophus: vel ipsi patriæ lapides cari. Et sic Themistocles, apud Metastasium, regi interroganti, quid tantum amaret in Athenis, mirabiliter respondit:

"Tutto, signor: le ceneri degli Avi,
Le sacre leggi, i tutelari Numi,
La favella, i costumi,
Il sudor che mi costa,
Lo splendor che ne trassi;
L'aria, i tronchi, il terren, le mura, i sassi."

Quis verò, viri gravissimi, ex Mexicanis, ave istis patriæ exuviis dicat quin et vobis illas conservantibus, gratias, easque quam maximas, referat?

Ecce vobis, quæ tantum mihi animum tantamque addidit audaciam, ut ante vestram sapientum coronam, ad me, gratum ergà vos, exhibendum sistam, rationem. Quod verò, vobis dignum donum, imò, non indignum, ex me devovere possim? Liceat mihi, et quæ pauper possum ante Minervæ, cujus vos sacerdotio fungitis, aras offerre. De Anahuac quæ dicturus sum agent, et illa etiam mihi cara, quæ juventutis oblectamenta fuerunt. Sunto nunc exilii spolia opima, ea si vobis placeant.

De antiquitatibus ergò Mexicanis orationem habiturus, non semel, sed pluries, dummodò id vos mihi concedatis honoris, ab eâ linguâ exordiri volo quæ, licet magis ab omnibus barbara habeatur, minùs recentibus formulis implicata, multæ ætatis, agrestem vultum, multorumque sæculorum ab hoc nostro, simplicitatem præ se fert. Non enim dulcis, ut Tarasca; non dives, ut Mexicana; non facilis, ut Huasteca; sed ea dura, jejuna, ori ingrata, aurique ingratior: nil in eâ non rusticum, nil non vastum, nil non inconditum. Populus, eam qui loquebatur, non cultus, non ullo disciplinarum genere perpolitus, inter septentrionem orientemque, in Anahuacensi plagâ, vitam pauperem, ferè sylvestrem degebat, nunc verò, hinc illincque divisus, à primâ eorum sede, ab Hispanis exules, non meliorem pristinâ, miserrimis pagis, vivunt illi. Eorum ipsi linguam, *Hiăhiū* nominabant, quod nomen fortassè Germani scriberent *Hiang-hiung*. *Hiă* apud eos, quod Latinis *sermo; Hiū* verò *sedere, manere, quiescere*, vult. Quapropter Hiăhiū, *sermo qui quievit*, interpretandum, verborum sensus postulat fidus.

Quæ hujus cognominis causa? Numquid alii inter eos populi iter facientes, alias loquentes linguas, diversos illis sermones sucessivè donârunt? Sed tunc illos propriam hospitibus donasse, non alienam ab hospitibus recipisse, credere oportet. An potiùs illi ipsi, multas distracti per terras, nunc hunc, tum illum ediscere sermonem, veterem frequentèr exuere, novumque induere, coacti sunt? Sed si eorum linguæ, pacis tranquillitatisque nomen imposuêre, seipsos *errantes, peregrinos*, appellaverunt. *Othomi* enim, ità interpretandum: *Otho*, nil; *mi*, sedentes; nomen valdè proprium, quibus nec etiàm sub Mexicanorum Hispanorumve imperio, sedere licuit. Undè ergò illi? Quas terras peragrarunt? Quas linguas ediscerunt dedisceruntque? Quam tandem Hiū, *sedentem*, denominabant? En quæ eorum à linguâ, petenda, si priùs ejus natura develanda cognoscendaque erit. Atque iterùm, an hæc ex earum numero, lingua erit quæ imminutæ, vel ex iis quæ auctæ Anahuacensi sub cœlo haberi debet? Nulla ne ibi soror? Non etiàm ejus Mater? Sine dubio, nobis certo certiùs illud esse potest, Mexicanam, Tarascam, Huastecam, Tarahumaram, Zapotecam, Matlatzingam, Pirindamque linguas alias omninò ab Othomiticâ, alium proindè earum originem esse. A Mexicanis verò eorum dominis, Huastecisve eorum vicinis, quod unicè poterant, id acceperunt, nempè, conjugandi artificium; cætera verò omnia si non integra, saltem incorrupta à patribus recepta, Othomiti, quod posteà videbimus, servarunt. Rudis illa, tamen nescio quid venerabile, antiquum redolens, lingua.

Si quis verò, ad barbaros homines, de barbarorum linguis moribusque, examinationem mandandam credat, ille Terentii dicentis, "nil à me humani alienum puto," meminerit, et quomodò homines veteribus fuerunt ætatibus, scire non dedignabitur. Prætereà, quos antiqui Indi modos, ad linguas perpoliendas ornandasque adhiberunt, Philologia optimè, nunc temporis, noscit, historia edocet, philosophia intellexit; interest ergò ut nunc et quo illæ linguæ pristino in statu fuerint, eâdem perfectione agnoscamus. Neque sua illi Othomitico pulchritudo deest: non quidem lenis, luxurians, nitida, sed ut rupes nuda, aut senex robur, ità quid asperum sed sublime videtur. Quæ quis pulchra non judicabit?

Utrùm aliquando scripta hæc Othomitorum lingua fuerit, quodve scripturæ genus habuerit, presenti tempore, discutere, ullo sine fructu, cùm certè illa scriptura, si unquam extiterit, cognita non sit, esset. Itaque de linguâ numquam scriptâ, loquuturus, non de litteris, sed de sonis quæ de ejus alphabeto dicenda sunt, me agere velle necessum puto.

Quinque vocalium literarum, *a*, *e*, *i* vel *y*, *o*, *u* (*u* Hispanici vel *ou* Gallici), sonos, diversummodè tamen expressos, habent Othomiti. A, enim aliquandò ex pectore exiens à nasu finalitèr exprimitur, aliquandò verò in gutture incipit, et repentino hiatu secatur, qui sonus agrestis, hispidusque est quem Ludovicus de Neve y Molina, voce Hispanicâ, *hueco*, Quintilianus *fuscam* vocem vocat; aliquandò tandem naturali, claroque sono, profertur.

E, tunc longissimè protrahitur, quasi balatum ovium imitans, undè Ludovico Neve y Molina hunc sonum *ovejuno*, quod Hispanicè *ovillum* sonat, vocare placuit; nunc verò gutture pectoreque incipiens, gradatim voce elevatur, cùmque fortior est, repentè quasi per aëra diffusus, disparet; quem sonum *gutturalem* nominare possumus. Hic enim è gutture natus, ascendit ut à nasu occidatur, quem sonum *nasalem* vocabimus; illic verò nullâ gradatione, æquali voce, ut *é* Gallicum et *a* vel *ay* Anglicum profertur.

I, duplici sono exprimitur; primo quidem naturali nobisque communi; secundo verò nasali omninò, ut Anglorum *ing*.

O, nullo vocis gradu modulatur, semperque ut *o* Gallicum exprimendum.

U, Hispanicum vel Italicum, aut *ou* Gallicum semper sit; non tamen eodem modo proferendum. Aliquandò nasu profertur, velut *ung* Germanicum; aliquandò verò gutturale, quasi grunnitum porcorum imitans; denique et naturali vocis motu dicendum est.

1. Quinque itaque Othomiti Indiani intonationibus, ad vocales exprimendas utuntur.

Prima enim quæ nimis protrahit sonum, utrùm *pking* Sinensium intonationi similis dici potest, sapientes decernent.

Secunda verò ex pectore guttureque incepta, cum fortior, tunc evanescit; fortassè *khin* sinico non discordans.

Tertia, à nasûs operâ acta, *chàng* sinensis nomine avocari, à recto non multùm devium iret.

Quarta ex gutture oborta, non multùm durat, cum repentè dùm plus valet rumpatur. Eritne ità ut sinicum *ji?* Alii viderint.

Quinta verò, vix intonatio dici potest: non enim vox ex eâ aut augetur aut minuitur, nec ascendit descenditve ullo ex gradu; semper illa, eâdem in viâ, ut ità dicam, decurrit: ut nascitur, ità vivere desinit.

Consonantium litterarum soni ità se habent. B, D, ut apud Gallos, G semper durum, ut apud nos antè vocales *a* et *o*; H fortitèr exspiratum, velut *ch* Germanorum; M, N, ut apud Gallos et Italos; GN ut ñ Hispanicum; P, K, R, ultima suavis semper, numquàm durum ut R Hispanorum; S, T, Z, ut Gallorum; W, Anglorum, in *water; ph* nec ut nostra *f*, nec ut *φ* Græcum, sonat; X, semper ut *ks*; CH ut Anglorum in *church*. Est et alius illis sonus, qui solùm *ts* litteris exprimi potest. K simplex vel duplex est. Duplex Hispano-Mexicani grammatici *cc castañuelas* vocant, quia ejus sonus similis est stridori à simiâ facto, nuces frangenti. Litteris *cc*, *qq*, vel *qh* oculis pingitur. T, aliquandò etiàm duplo sonitu effertur.

Non tamen id satis, cùm multa verba incipiunt finiuntque, cùmque duobus ex syllabis unum verbum faciunt, medio verbo, et gutturis et nasûs, et anhelationis hiatûsque intonatione, vocem modulant; quæ, quomodò nostris litteris exarari notarique possent? Quâ de causâ, illi qui priùs de linguâ difficile onus scribendi sibi assumpsêre, aliquandò *h*, aliquandò *ng* aliquandò *nn*, et etiam *nug*, *mm*, litteris, ad illa exprimenda usi fuêre. Hinc enim, liquidò constat illud, ni fallor:

2. Nostris, nec Hebræis, Græcisve litteris lingua illa scribi, non nisi difficillimè potest.

3. Deindè, nullâ viâ nos homonyma verba, quorum varia significatio, seu gestibus, seu levi modulatione, expressa, etiam cum loquuntur, nisi ex circumstantibus distingui nequit, separare aut annotare possumus.

4. Suâ itaque sui generis scripturâ indigeret Othomitorum lingua, si scribenda foret.

5. Ità illius generis scriptura invenienda, quæ non modò litteras, sed et intonationes ipsas depingeret; nàm diversa intonatio uni verbo diversum sensum donat. (Vide annotationem, in fine, sub littera A).

Et hoc licet punctis, ut Massoreticis, exempli gratiâ, assequi, haberique possemus, tamen adhùc vacuum nobis implendum esset; nàm multa verba iisdem sonis iisdem et intonationibus, non idem significant. *Hē* enim, exemplì gratiâ, mons; *hē* glacies; *hē* fingere, est. *Moui* cor: *moui* anima: *moui* animi indoles: *moui* animi motus. *Nheau* bonus: *nheau* pulcher: *nheau* aptus: *nheau* justus: *nheau* perfectus: *nheau* urbanus, aliaque innumera; quapropter:

6. Othomitica lingua, eo scribendi genere indigeret, quo et diversus verbi sensus ex diversis signis animadverti posset.

7. Hoc forsitan, sinicis signis, obtineri liceret.

8. Est, itaque quædam inter utramque linguam analogia.

9. Proindèque, earum natura, non multùm dissimilis credenda. Quod quidem, nec affirmare, nec negare audeo; hoc verò quomodò

possem? illud nolo; sed facta solùm exponere meum est; quisque ex iis quæ sequantur, ea mecum considerabit.

10. Nomina aut unâ aut duobus constant syllabis, perpauca tribus; hæc verò post dominationem Hispanam, ut puto, composita. Quæ diversis hisce syllabis componuntur ità generis sunt, ut quæque syllaba pristinum sensum earum quælibet retineat, ac servet. Undè, nomina, quæ plures quam unam, syllabas habent, ex syllabis aliquid significantibus anteà, præexistentibusque, et in compositione earum significationem haud amittentibus, formantur. (Vide Annot. A. B. et C).

Nullum inflexionis genus illa nomina cognoscunt: eumque idem quod nomen, id verbum; idemque, ut nomen substantivum habeatur, particulâ *na*, quæ in istâ linguâ *unum*, ac etiam, pronomen *ille*, *illa*, *illud*, significat, undè articuli vices gerit, afficitur. Non tamen id, nisi cùm dubii, vel æquivoci periculo adest. Plurale à singulari nomine, cum *ya*, vel *yē* aut *ē* discernitur. *Yē*, vel *ē* pluviam significat, *ya* particulæ significatio ignoratur.

10. Una itaque particula sensu carens esse dici potest.

11. Et nomina omninò flexionibus carentia.

12. Nullum nominibus genus. Quod adjectivum, id et substantivum est (vide not. D). Adjectivum substantivo præit. Cum adjectivum pro substantivo ponitur, *na* in *sa* mutatur, ut *na nheau*, bonitas; *sa nheau*, bonum; *na nheau yĕh*, bonus homo. *Sa* nil per se significat, significationem adjectivam designat.

Particularum auxilio quæ et tempus et personam indicant, verba conjugantur. Triplex cuilibet tempori particula: quæ in singulari, illæ in plurali numero; undè hic ab illo, pronominum *hē*, nos; *wi*, vos; *yu*, ille, auxilio distinguitur. Quatuor supra decem particulæ illæ sunt, sensuque, nunc temporis saltem, ut quæ apud sinenses *vacuæ* vocantur,* carent. Indicandi, imperandique modos solùm Othomiti cognoscunt. Secunda imperativi persona, nullâ omninò notâ, particulâve afficitur, sed diversimodè illa formatur: aliquandò enim, verbo repetito, ut *Tè*, facere, *Tètè*, fac: aliquando verò vel nomine vel verbo adjuncto, non absimili significatione separato, ut *O* recordari, *Op'ho* recordari et cognoscere, recordare tu, nempè *scribe* (id enim sibi vult *Op'ho*) et

* Remusat, Grammaire Chinoise, p. 35, sect. 62.

non semel tandem verba illa, *facere*, *exequi*, *uti*, *exercere*, *in executionem mandare*, verbo jungenda erunt; sic *O* recordari sibi, suprà ut vidimus, vult, et *Khā* facere; *Okhā* memento. Quod quidem eam personam conficiendi artificium, antè particularum inventionem usumque, et incæptum, anteàque inventum, quis non videt? Undè,

13. Tempus fuit, quo conjugationis, ut nunc, artificium in eorum linguâ non haberent Othomiti.

Veteris formæ tempora distinguentis vestigia, adhùc lingua retinet. Quod quidem omnibus Anahuacensibus linguis accidit, ut pristinæ naturæ non omnia amittant, licet longissimè ab earum origine sint; quod et aliquandò futurum, ut discordiæ horridus ille Diabolus, Mexicum cruciare, turbareque fatigatus saltem desistat, mei concives, linguarum earum, proindèque Indorum ortum itineraque reperturos, credere, sperareque nos monet. Quamobrem Indi Othomiti, præsenti et nunc tempore, verborum conjugationi; *ma*, *ni*, *nā* adjectiva, aliquandò addunt. Non quidem frequens hic usus, antiquior et ideò. *Mā*, præterita res; *ni* præsens; *mi* ventura; *mā pa* præterita dies, *ni pa* præsens dies; *na pa*, futura dies. Illi ergò non semel ità dicunt *ni di mā*, ego amo: *mā da mā* ego amavi: *na ga mā* ego amabo, quod superfluum inutileque est, nàm *di mā*, *da mā*, *ga mā*, idem ac sine illis adjectivis, exprimit. Neque verò, quis illos elegantiæ ergò hæc addere putet; non enim illi elegantes se curant, neque euphoniæ causâ id faciunt; nam rarò illa nomina addunt, et se miseros putarent, si ità essent delicati ut euphoniam quærerent! Fortassè multa linguæ pars, ut Itali dicunt, *se n'andarebbe nella limatura.*

Eodem conjugandi artificio, Othomiti ac Mexicani eorum Domini, et Huasteci eorum confines, utebantur, quod animadvertere à re alienum non est. Eorumne omnium linguæ eundem fontem habuerint? eademne, illi ex radice rami germinarunt? Id impossibile, illas cognoscenti, videbitur. Non enim Othomitos formam eam ad verba conjuganda, initio vidimus habuise. Aliundè quidem illam receperunt; à Mexicanâ, nempè vel Huastecâ, ut videre hâc ex collatione, est.

En triplex illarum linguarum conjugandi artificium. *Chihua* apud Mexicanos, *Tahjal* apud Huastecos, *Tè* apud Othomitos, idem tria illa verba, quod *facere* apud Latinos, sunt. Quo quilibet ex eorum, artificio, ad eum conjugandum utebantur, videamus.

Mexicanus,	Ni	chihua	Ego facio.
Huastecus,	V	tahjal	
Othomitus,	Di	tè	
Mexicanus,	Nite	chihua ya	Ego faciebam.
Huastecus,	In	tahjal itz	
Othomitus,	Di	tè hmā	
Mexicanus,	Onitla	chiuh	Ego feci.
Huastecus,	V	tahjamal	
Othomitus,	Xta	tè	
Mexicanus,	Onical	chiuh ca	feceram.
Huastecus,	V	tahjal ac	
Othomitus,	Xta	tè hmā	
Mexicanus,	Ni	chihuaz	faciam.
Huastecus,	quia	tahja	
Othomitus,	Ga	tè	
Mexicanus,	Onitla	chiuh	fecero.
Huastecus,	V	tahjamal	
Othomitus,	Ga xta	tè	

Imperativo nulla omninò inter illa et Othomitica verba artificii similitudo. Sed in triplici illâ linguâ modus infinitivus non invenitur, et in eis futurum imperfectum pro infinitivi temporibus vices gerit. Ità enim, exempli gratiâ, hæc oratio, *Ego volo facere*, reddi oporteret;

in Mexicano,	Nieniqui	chihuaz
in Huasteco,	Vle	quia tahja
in Othomito,	Di ne	ga tè
id est,	Volo,	faciam.

Tanti momenti res, ut verba conjugandi artificium, tam simile in linguis suâ ex naturâ tam diversis, casu efformari quomodò potuisset? Ejusdem effectus, eadem causa. Ejusdem linguæ filias, Othomiti et Mexicani linguas quis credet? Una igitur ex iis linguis ab aliâ, formam illam, imitatione recepit. Ab Othomitis, vix ad duos conjugationis modos sequendi capaces, Mexicani mille conjugandi verbi modis, generibusque onusti emendicarent? Othomitine suâ in linguâ omnis compositionis expertes, verborum formularum donum, Mexicanis syntheticarum formarum peramantibus et Polysyntheticam linguam vel infantem loquentibus, fecissent? Absit. Iterùmque hic videmus, quod,

14. Ab alienis, Othomiti conjugandi formam receperunt, ac,

15. Suo initio proindè, lingua illa conjugationis formis caruit.

Si quis verò, Othomitos Indos conjugandi formam à juvene illâ linguâ Mexicanâ, quam et culta natio perfecit, quâ miserrimus ille et rex et philosophus Tezcocanus Netzahualcoyotl elegiaco versu, sublimi plectro, ejus omnisque humanitatis casus deploravit, quamque tandem Hispani, floridam, phaleratam, ornamentis luxuriantem, divitiis affluentem admirârunt, non recepisse contendat, is veri metam fortassè attinget, etiam si conjugandi artificium Othomitis, agrestem, senem, rugis aratam, voce rusticanam illam quæ olim in utero, nescio quibus à regionibus, Mexicanam illam, gratiosam, et pulchram portavit, quamque mundo in Anahuac edidit, dedisse existimet. Sed de hoc aliàs, nil enim ad præsens. Mexicana lingua, alterâ antiquior, conjugare verba Othomitos docuit: esto: quid deindè? cujuscumque illud jus sit, illud rapiat, aut vindicet; non cum eo disputabimus; quantò enim magis, pluresque linguæ, primum illarum formarum dominium vindicent, tanto certius illud erit, Othomitos aliquandò non habuisse has formas, ab eorum linguâ alienas, ab eâque proindè, cum de eâ judicare velimus, rejiciendas.

16. Othomiti non nisi activa verba conjugant; non illis passiva, non compulsiva, non casualia, non denique ullum eorum verborum quæ sive nostris, sive aliis Indianis linguis inveniuntur, genus.

17. Verba illa, unius sunt syllabæ, aut ad summum, duobus syllabis constant (ut videre est in annotationibus sub litteris A et C.

18. Verba quæ suâ ex naturâ sunt, plures quam unam nunquam syllabam habent; undè imperativi secunda persona alio cum verbo formatur. (Vide Not. C.) Hoc secundum verbum, sensum primo analogum, vel illum intensiorem ut ità dicam, vel extensiorem, secùm portat; quàpropter:

19. Omnia verba unâ tantum syllabâ constant, imperandi tempus si excipias, in secundâ personâ:

20. Secunda hæc persona duplici syllabâ, duplicem sensum evolvente, constituitur.

Prætereà, omnia nomina verba esse possunt. Cùm enim, substantivo verbo careant Othomiti, verbi illius sensus, idem ac attributum, sive, ut scholastici vocant, prædicatum, putant; aut ut clarius dicam, ad existentiæ ideam à re existente distinguendam cum impares sint illi Indi, unà simul utramque ideam involutam considerant. Itaque, si Othomitus vult dicere, *ego sum bonus*, ex nomine *nheau*, bonus, verbum *esse bonum* significans format, idque conjugat, ut *Di nheau*, vel *Dna nheau*, ego sum bonus; undè cùm frequenter illa nomina ex duobus syllabis, ut quæ ex duplici significatione composita sint, verba habemus duplicis spllabæ quidem, sed duplicis sensus etiam conjuganda; quapropter:

21. Verba ex nominibus facta, dupli syllabâ duplicem sensum evolvente, conjugantur, si duplices illa syllabæ sint. Cùmque hujusmodi verbis, non usus, ut cæteris, secundum verbum vel nomen designarit, cùmque sine eorum aliquo imperativi persona efformari queat, hoc in casu Indi *we*, quod *es* vel *esto* dici potest, nomini in verbum commutato addunt, ut *nheau we*, bonus esto. Triplex syllaba tunc, sed etiam triplex sensus habebitur, si nomen duplici syllabâ constabit, ut *memthi*, dives, *di memthi* (aut *memthi*, et fortasse meliùs) sum dives, *memthi we*, dives esto.

Sed quâ ratione, quis petet, in parvis quæ de Othomiticâ linguâ, vocabulariis vel lexicis habemus, ut plurimùm, verba duplici constant syllabâ? Quia, eorum auctores, imperativi secundam personam, ut quæ pro secundâ syllabâ, ab aliis homophonis verbis, et distinctior, et determinatior est, ibi posuêre, eo, quidem, modo quo nos, nostris vocum indicibus, verborum infinitivum inscribimus. Sanum, laudeque dignum consilium. Non tamen illud, dicet quis, auctores isti, patefecerunt, aut explanarunt. Fecêre utique, atque ut alios qui et posteà et illius sequentes vestigia scripserunt, ut Sanchez et Rangel omissos faciam, eum, qui meliùs, hâc de linguâ scripsit, Ludovicum de Neve et Molina (Anno MDCCLXVII), consulamus. Ille enim, natione Othomitus, in ejus de hâc linguâ institutionibus, pag. 122 animadvertit, verbum per secundam imperativi personam cognitum fieri, ut quod hâc in personâ nil additum illi, nilve subtractum futurum iri credit. Quod ut meliùs intelligatur, operæ pretium est animadvertere, illum imperativum quasi radicem verborum credebat habebatque; ex illo enim alia tempora formari voluit. Quo factum fuit, ut obscurè, difficillimè, verbi artificium exposuisset. Nec mirum; omnes enim qui de Indorum linguis scripserunt (paucos recentiores si excipiamus, ut Sandoval, Avila, aliosque), et institutiones efformarunt, Antonii Nebricensis vestigiis adhærentes, eas Latinis sub formulis explanare, totis viribus insudarunt. Tempora illa ità ferebant. Nec tam eos benè de meâ patriâ deque litteris merentes reprehendendos, quod summæ audaciæ temeritatisque esset, quam ad eos explanandos, istius generis laboribus manum apposui.

Sed benè, repones, illis in lexicis, quædam verba illa sine secundâ syllabâ inveniuntur. Id ut verum fateor: ità enim ea verba à lexicis exhibentur, ut quæ nec in imperativo, alterum verbum recipiant. Quæ illa, paucissimo quidem numero, sint verba, et rei causam intelligemus. Sunt enim illius illa generis quibus frequentiùs utitur, et quorum sensus cum alio confundi nequit: ea etiam quæ difficilitèr analogo alio adhærerent, ut *tsi*, manducare; suntque tandem illa quæ familiari sermone nunquam imperantur, ut *tē*, senire, *doū*, mori. Non enim illi miserrimi Othomiti sermone figuris loquente utendi ocasionem habuerunt, non poësi ut Tarasci indulsêre; non denique orationes ad populum, ad regum cœtum, ad principes, ut Mexicani, faciebant. Duo hic animadversione digna, sese consideranda offerunt; unum idque primum, maximo rusticitatis statu Othomitos, longo temporis tractu degisse, alterum, priusquam verba temporibus distinguerent, fuisse tempus, quo nec imperativum distinguendi modum habuissent.

22. Triplex verborum, Othomitorum in linguâ, considerandus status, primus cùm nullum tempus, nullus modus, nulla persona, in verbis distinguebantur; secundus, cùm alii verbi auxilio, verborum imperativum formarunt; tertius, cùm alienam conjugandi formam receperunt.

Quæ cum contemplantur, quis non Othomitorum sermonem minimè à pristino statu remotum videt? Non temporis spatio confectus, sed ex naturâ totus ut Minerva à Jovis capite, si me ità explicare liceat, ortus. Prætereà, quàm non illa sermonis forma antiqua! Quis ergò, quousque in sæculis, linguæ Othomiticæ vetusta ætas attingit, dicere potest?

Utut hæc sint, ad verba illa redeamus: ipsa enim nimis sterilitate laborant. Non ex iis participia, non gerundia, non abstracta nomina spectes. Quem enim ad modum, quod apud eos adjectivum quando illis placet, substantivum fit, ut *sa nheau* bonum; *na nheau* bonitas, ità etiam verbum ipsissimum, nomen abstractum est, ut *mādi*, amare, *mādi*, amor. Hoc enim à *mādi*, secundâ personâ imperativi sumitur. Inter has voces differentia, aliquandò sententiarum contextu, frequentiùs verò vocis labore procedit. Grammatici leves has articulationis differentias, cum duplici *tt*, vel literâ *h*, distinguere tentant; sed vani hi conatus; istæ vocis differentiæ, chartæ commendari haud facilè possunt.

Concreta nomina, verbo *tè*, facere, hic substantivè intelligendo, duobus modis formantur; verbo ista syllaba additur, ut *mātè*, amator, amans; aut imperativi secundæ personæ verbum *tè* adhæret, ut *mādi* (*di* et *tè* idem ferè significantes), dummodò alterum verbum sensu non repellat: itaque *creator*, exempli gratia, dicitur *tètè*, nam ridiculum esset dicere *tètètè*, quod idem esset ac *actionis factor factor*.

Solemne apud eos est, ut *too*, qui (relativum), quod hujus modi nominibus præponant, ut *too mātè* qui amat, vel amans. Ex dictis liquet,

23. Nulla verbalia propriè dicta, verba habere, et

24. Quæ sunt, syllabâ additâ, verbum significans recipere.

25. Adverbia adjectivis à nominibus non alia sunt. Omne adjectivum, igitur, adverbiali sensu intelligi potest, ut *nheau*, bonum; *nheau*, benè. Aliquandò, et aliud adjectivum addere licet, nempè, *theau*, omne, ut *nheau theau* bonum omne; quod sonat ut apud nos *benè est*.

En puram, ut puto, linguæ Othomiticæ imaginem: si qui Indi illius naturam simplicem, ornamenti varietatisque ergò, vitiare conantur, quid de illis parvi momenti adhùc mutationibus judicare debeamus, ex Domino de Neve audiamus. "Todo lo qual no pertenece à lo substancial precisamente, ni al general uso de todos los nativos, sino à la mayor energia con que hablan los mas cultos, por lo cual, aunque no se observaran estas reglas, no por eso dejaria de entenderse lo que se quiere decir," id est, "Quæ quidem mutationes (nempè litterarum commutationes, ut *t* pro *d* in quorundam verborum præteritis, aliæque hujusmodi), non conveniunt linguæ, suâ ex naturâ: neque communis loquendi apud Indos usus, eas tolerat, nec fert. Novæ hæc formulæ, elegantiores ab Indis cultioribus additæ sunt, ornamenti elegantiæque gratiâ; id tamen illis parvipensis, nequid detrimenti sensus linguave accipiunt." Quibus in verbis initia corruptionis, linguam deformantia videmus, nàm ut illa meliùs capiantur, nos illud scire debemus, cultiores *ladinos*, hoc est Latinos, eos Indos in Mexico vocari, non qui in eorum linguis instructiores, eorumque morum tenaciores, sed qui et meliùs hispanè sciunt, qui et Hispanorum sermonis formulas et mores affectant.

Quæ cum ità se habeant, quod de linguâ eâ judicium faciendum videamus.

Nomina, Othomitos apud Indos aut unius sunt syllabæ, aut si plures habent, quælibet ex iis sensum pristinum non amittunt (ex paragrapho No. 10), et earum omnia aliquid significant. (Ex numeris 17, 19, 21, 23.)

Verbalia nomina quæ vocari possent, aut nullam verbo syllabam addunt, aut si addunt, et sensu nova syllaba haud caret. (Ex numeris 25, 26.)

Adverbia aut ipsissima adjectiva sunt, aut si alteram syllabam recipiant, hæc nomen significans est. (Ex numero 25.)

Quotquot itaque syllabæ in Othomiticâ linguâ sunt, earum quælibet, sive per se sit, sive alteri unita adhæreat, semper significat, pristinumque sensum retinet, demptis tamen sex supradecem particulis quæ, ut apud sinenses, dici possunt *vacuis*. Cùmque ea lingua, cujus omnia verba aut monosyllabica sunt aut ex syllabis pristinum sensum non amittentibus constent, quin paucæ exceptiones, cujus pristina significatio lapsû temporis oblita est, ad id afficiant, (ut mihi vobisque optimus, præses ille vester, Petrus Stephanus Duponceau, dixit in primis), ut lingua monosyllabica dici debeat, Othomitorum lingua monosyllabica vocanda habendaque est.

Cùmque id omninò possibile non sit, ut monosyllabica lingua, à syntheticâ, minusque à polysyntheticâ ortum ducat; sine hìc fallendi timore, hæc stabilire licet.

Othomiticæ linguæ origo aliàs omninò à Zapotecæ, Huastecæ, Mexicanæ, Tarascæ, Tarahumaræque linguarum Anahuacensium, cùm hæc nunquam monosyllabicæ fuisse videantur, origine quærenda est.

Diversæ itaque illorum Indorum, nempè Othomitorum, dictarumque suprà tribuûm, aut si ab hinc retrò multis sæculis unius familiæ filii fuerunt, multis sæculis etiam ab hinc retrò sejuncti, diversas terras peragrarunt, non eâdemque viâ ad Anahuac cœlum petendum, iter fecêre eorum utrique.

Othomiti præterea, alicujus nationis, verbis monosyllabis loquentis, aut posteritas, aut hospites. Quæ illa natio? quo id tempore? Erit aliquandò, cùm philologia, quæ secreta illa historiam fugerunt inveniat, ac doceat.

Si enim Othomitica lingua monosyllabica dicenda, multa illi homophona esse verba necesse est; et sunt quidem illa. Vocalia, non æquali sono dicenda; nec intonationibus, præter sonos, Othomiti indigent. Cùm verò illæ plures esse nequeant, nec illis homophona omnia verba distingui possunt. Quà propter, ex partium dispositione aliisque circunstantibus, verborum, cùm lingua voce effertur, significatio pendet, et notis, illâ scriptâ, ad significationem designandam, opus est. Nostris id nos litteris præstare non possumus. Itaque, sua illæ scriptura peculiaris invenienda. Ac proindè non ex Hebræi, non ex Græci, nec denique ex recentioribus linguis illa petenda. Non itaque Othomitorum lingua, ex iis, undè Hebræa, Græca, Latina recentioresque linguæ, fontibus exivit. Ex dictis illud videmus, non monosyllabicæ nomen linguam eam demereri.

Sed, si ità esset, suo initio omne compositionis genus abhorruisset? Et quidem cùm solum quod illi est, nempè conjugandi artificium, ab exteris alienisque receperit, nulla illi suâ ex naturâ synthetica forma, ac proindè, nulla hujus generis compositio. Deindè, cum sinensium linguâ monosyllabicâ, unius naturæ, ut ità dicam, utraque lingua consideranda, atque tunc fieret, ut Othomitorum illa sinicis notis scribi posset? Certum id; sed et illud, sinensium scripturâ, optimè excellentèrque præstandum, si opus esset, vidimus. Quapropter, nec hisce ex partibus, ut monosyllabica habeatur, jure Othomitica spoliatur.

Benè se itâ res habeant: sed quæ de linguâ Othomiticâ institutiones sunt scriptæ, alitèr videri videntur de eâ eorum auctores cogitasse? Nequaquam, viri gravissimi, sed aliam ab hâc illis viam, ut se explicarent, eligere placuit. Antè omnia, illi linguam ut scriptam considerârunt, illi et etymologiam et orthographiam adaptârunt, deindè illas cum orali linguâ comparantes, cùm unam Niobem, ab aliâ toto aliquandò cœlo distinctam vidissent, ut utrâque unam facerent, quod alitèr non poterant explicare, *syncopen* appellarunt. Ego de linguâ vocali, illi de scriptâ, ut loquatur, scripsêrunt. Prætereà, non in rebus, sed in verbis formulisque, illas explanantibus, eos inter et me est discordantia. Solemne fuit illud de Anahuacensibus linguis scriptoribus, ut eas ad Latinum compararent, totisque viribus coæquarent, nec id solum, sed et Antonium de Nebrixa (celebrem apud Hispanos linguæ Latinæ Grammatices auctorem), ducem sequentes, constantèrque imitantes, omnia ad hujus doctissimi viri de Latino institutiones, et regulare et explanare voluêre. Ipsas illi loquendi formulas, quarum magnâ ex parte, nec ab ipsis Mexicanis comprehenduntur, ex parvulis chartis à magistris, Nebricensem opus explanandi gratiâ, scriptis, assumpsêrunt. Hinc enim et verborum in Huastecâ linguâ, passiva vox erupit: et quinque Mexicanorum declinationes, et alia innumera, quæ infinitum esset recensere. Quæ quidem eorum virorum qui nobis multa bona et fecerunt, et curarunt ne perirent, pace dicta, et velim et opto. Neque quis nisi injustitiâ, impudentiâque plenus homo illud illis vitio vertere audebit. Quis enim Græcos, quis Romanos, barbaros habebit ex eo quod acum nauticam, quod Copernici, Linnei, Neutonii detectiones, ignorârunt? Novum, quidem, iter à Philologiâ monstratum est; nunc verò tempus, quo et quæ illos præteriêre cognoscere, et quæ solùm prospexêrunt, meridianâ luce ponere, et quæ obscurârunt, dilucidare nunc possunt sapientes. Quod quidem quàm multi ex Mexicanis, suis illis Anahuacensibus linguis præstabunt, non dubito, illi postquam id cognoscant, quanti apud vos, viros sapientissimos, istius generis labor habetur; nàm nil apud Mexicanos, tam cordi est aut unquàm fuit, quam eorum patriæ et honor, et gloria. Itaque benè si vobis ego, meâ fortunâ, vestrâque indulgentiâ nunc audierim, quos non ex meis concivibus, vobis de Anahuacensium linguis, historiâ, naturâ, eâ quâ mihi eloquentiâ, doctrinâ, et philosophiâ non licet, erunt loquuturi! Mihi satis gloriæ obtigisse, si eos antè viam quam illi floribus spargent, irem, et aliquandò ipsos unà vobiscum, nobis et linguarum originem, et hominum qui antè nos hoc in novo orbe fuerunt, iter indigitantes, naturæque divitias quæ, nostris sub solis, affluunt, demonstrantes, et videam et audiam. Utinàm, et sub pacis alis et umbrâ, vestro exemplo, in Anahuac, sapientes unà congregati, quod vos hic pro relligione, pro patriâ, pro humani generis salute, facitis, illic terrarum, aliquandò agere incipiant! Me felicem, cùm et ut vestrâ, meâ in Patriâ, altera academia vestra soror, vestra et amica, eâ quæ vos gloriâ circumfundit non indigna, stabilienda erigendaque erit! Nascatur illa quantociùs; tu verò, hujus Reipublicæ ornamentum et columen, ESTO PERPETUA.

Pars Altera.

Licet tota in id incumbat Historia, viri gravissimi, ut humani generis acta, sive mortuâ scripturæ voce, sive vivâ populorum traditione, posteritati salva integraque servet, mille tamen de causis, quarum magna nobis pars adhùc est incognita, accidit, ut memoria de multis omninò deperierit, et alia non nisi fabulæ cantu, nostras ad aures usque, pervenerint. Et multa quidem tenebris sic undequâque fusa sunt, ut nostros oculos fugiant, et quam ea prospicere, potiùs nobis suspicari, et vix id, liceat. Tempus invidum, naturaque haud semper sibi constans, fœdus inter se, ut quamplurima obliterata facerent, iniisse videntur. Non pauca ex iis philosophia, divinationis quodam, ut ità dicam, numine duce, inveniit: multa in pristinum, multis, eheu! laboribus, sudoribusque restituit: multa tamen, à longè contemplabat, neque quâ viâ lucem ad ea cognoscenda ducere posset, licet id multotiès tentavit, adhùc detegere potuit. An non hujusmodi, generis humani emigrationes itineraque sunt? Quid enim nobis de hominibus Americam olìm habitantibus, antequàm noster hic orbis à nostris inveniretur patribus, philosophia hucusque notum fecit? nil, nisi aborigines illos, quos Indos vocamus, licet alio magnâ ex parte colore (cùm albâ cutis colore non desint Indianæ tribus) eâdem ac nos naturâ homines fuisse. Qui, verò, illi homines? undè venerunt? quà iter fecêre? Hæc illam excruciabant: ipsa verò hæsitabat, nec quæ ignorabat docere poterat. Ad historiam illa tunc sese vertit; antiquas horum populorum traditiones, confusas, obscuras, et ut sybillæ oracula, vera falsis miscentes, quæsivit, et diligentèr indagavit, ac Indorum mores, vetera Anahuacensia monumenta, nunc simplicia et rustica, ut quæ Abrahami Jacobique temporibus erigebantur, tùm Ægyptiorum majestate pollentia, et non pauca Græcâ suavitate et elegantiâ perpolita, Philosophiæ Historia indigitabat; sed quid aliud, illa ex Mistlæ Palenqueque Templis, sepulchris, domibus, ubi non Zapotecæ, non Tcholi, sed alii istis antiquiores populi nobis ignoti, falsas divinitates adorârunt, mortuos sepeliebant, et vitam degêre, nisi illa nuda, solitaria, mutaque facta, philosophiæ apparuit? Nihil omninò. Nec ideò tamen philosophia desperavit; sed novam sibi viam aperuit. "Populi illi," (sibi ipsi secùm illa cogitans, menteque revolvens), dixit: "muti non sunt; illi loquuntur: benè se res habeat; ego eos adibo, auditura ero eorum linguas, aliis et inter se illas comparabo, et ad eos tandem cognoscendos perveniam. Linguæ non mentiuntur."*

En novum philosophiæ munus, et nova humani generi ex philosophiâ beneficia! Quæ non ex tunc illa, philologiæ sub nomine, perfecit! Quot homines celebres non reddidit! Quas eo ex tempore, veritates in lucem prodidit! Nondùm enim opus absolvit; illud prosequitur, et ad finem usque tandem aliquandò deducet. De linguis enim Anahuacensibus, aliisque illis vicinis, nonne philologiæ judicium adhùc desideratur? Nobis opus, ut eas illa audiat, comparetque, ut quid tandem de illis sentiendum proferat, decernat, præcipiat. Et quò, deus optime, nos illa deducet! quas ipsa veritates omninò novas, incognitasque explanabit, ac docebit! Quis enim unquàm Peruvianos inter et Anahuacenses Indos commercium extitisse, ex historiâ audivit? Tamen, tantam inter Tarascam et Quichuam linguas affinitatem, imò potiùs et cognationem invenimus, quæ casui ille solùm attribuet, qui casualitèr ipse cogitet. Quid de Mexicanæ, Hebraicæque linguarum similitudine dicam? Illa, licèt maxima inter eas sit, adhùc quam probata, potiùs suspecta, aut odorata fuit. Itaque, Othomitorum linguæ genere jam cognito, illius cum quibusdam aliis novi orbis, deindè veteris etiam linguis comparatio, tùm ut ejus natura cognoscatur, cùm ut illius origo investigetur, operæ pretium est. Illa, ut primâ ex parte hujus dissertationis vidimus, Othomitorum lingua monosyllabica habenda est; nec cum Mexicanâ, Corâ, Tarahumarâ, Huastecâve aut Zapotecâ quæ per particularum antè et postpositionem, nec cum Quichuâ, Tarascâ, et Matlatcingâ quæ per earum interpositionem, non modò syntheticæ, sed polysyntheticæ sunt vocandæ, comparari potest. Undè igitur ejus origo? Est enimverò alia Anahuacensis Monosyllabica, *Mazahui* nempè lingua, quæ ità Othomiticæ simillima, ut potiùs quæ inter eas cognatio, quam comparatio quærenda; quod alio

* Languages do not lie.—*Horne Tooke.*

et tempore et dissertatione, Deo favente, præstabo. Una alterius aut mater aut soror, undè ad alias oratio et mens vertenda sunt.

Nihil, igitur, in novo hoc orbe, hujus modi invento, mens statim ad antiquam, venerabilemque Confucii linguam advolat, ac curiositate nimis affecta, earum comparationem instruere desiderat. Si enim Othomita illius roboris ramus avulsus fuit, Indos illos, qui talem sermonem habent, loquunturque, aut sinensium filii, aut hospites fuisse credi, vel saltem suspicari possunt. En scopum philosophiæ dignum! Utinam hæc facta investigare et has linguas comparare mihi liceret! Sed, me miserum, qui linguam sinensem vix extremis labiis degustavi! Auxilio, tamen, istius linguæ grammatices, ab illustri viro Abel Remusat compositæ et in lucem editæ, aliquam comparationem hanc linguam inter et Othomitam tentare audeo. Pro sinensi loquetur ipse Remusatius; ego de Othomitâ solùm tractabo. Ultrà petent alii; memorem esse me decet veteris sententiæ: "ne sutor ultrà crepidam." Operi manum admovere incipio.

1. De lingua Sinensi ità Remusatius loquitur, in libro lucidissimo cui titulus: "Elémens de la Grammaire Chinoise" (Edit. Paris. 1822), p. 35, sect. 60. "Les mots pris séparément, sont tous invariables dans leur forme; ils n'admettent aucune inflexion, aucun changement, ni dans la prononciation, ni dans l'écriture." Othomiticæ linguæ omnia etiàm verba, nullâ inflectione mutantur, et ut plurimum, nec diversâ efferuntur pronuntiatione, nisi quædam, non multa quidem, quæ uno modo, cùm nomina, alio cùm verba sonant, ut *mā*, amare, et *nmā*, amor, quasi *na mā*, ille amor, Gallicè, *l' amour*. Vide suprà quod dixi in primâ parte hujus Dissertationis, de particulâ *na*, quæ articuli vices gerit. Notanda tamen est hìc differentia, sinensem linguam inter et Othomitam; nempè quod prima articulo caret, in alterâ nunc saltem, si sic in veteri linguâ non fuerit, multotiès invenitur.

2. Ibid. sect. 61. "Les rapports des noms Chinois, les modifications de tems et de personnes des verbes, les relations de tems et de lieux, la nature des prépositions positives, optatives, conditionnelles, ou bien se déduisent de la position des mots, ou se marquent par des mots séparés." Quæ eadem omnia et evenire in Othomiticâ linguâ jàm vidimus, ex primâ parte hujus Dissertationis, et iterùm ex annot. D. videbimus.

3. Ibid. sect. 63. "Beaucoup de mots Chinois peuvent être pris successivement comme substantifs, comme adjectifs, comme verbes, quelquefois même comme particules." Idem Othomiticam linguam præstare jàm vidimus, ex primâ parte hujus Dissertat. Num. 10, 12, 21, et post ex Annot. F. videbimus.

4. Ibid. sect. 70. "Il y a des mots Chinois qui sont toujours adjectifs ou substantifs, d'autres qui sont tantôt noms et tantôt verbes." Quæ conveniunt optimè Othomiticæ linguæ.

5. Ibid. sect. 70. "Le sens des verbes se déduit de la position respective des mots." Hoc verò in antiquâ sinensium linguâ, in recentiori (Remusat, ibid. p. 133), particulæ tempus verbis designant; quem quidem admodum, pristinâ ætate, ab Othomitis fieri utebatur; nunc verò et personas et verborum tempora particulis Indi isti distinguunt. En secundam, utramque inter linguam distinctionem.

6. Ibid. sect. 71. "Il n'y a pas de signes pour les genres. Beaucoup de noms spéciaux marquent les sexes dans les animaux. On détermine le sens de ceux qui sont communs, quand cela est nécesaire, par l'addition de certains mots tels que *fou* (pater), *mou* (mater), *jin* (homo), *niù* (mulier)." Neque in Othomi ullum ad genus distinguendum signum. Animalia aut diverso nomine, diverso esse genere cognoscuntur, propriumque illis pro genere nomen, aut verbis *ta* masculus, et *niou* femina, distinguuntur, ut *ta yo* canis masculus, *niou yo* canis femina.

7. Ibid. sect. 72. "On n' ajoute ordinairement aucun signe pour distinguer le singulier du pluriel; on dit indifféremment *jin* homo, aut homines." Hoc de antiquo sinensium sermone. In novo quidem (ex sect. 297, p. 112): "Le pluriel se marque, soit par les particules préposées *tchoung* ou *tchou*, soit par les noms de nombre indéfinis. soit enfin par les particules postposées, *toû* et *hiâi*." Inter Othomitos. pluralis à singulari numero particulâ *ye* (pluvia) vel *ya*, vel *e* discernitur. Singularis suam etiàm particulam, *na* vel *ma* aut *ra*, habet, quâ sinensis caret, undè hìc, parvi momenti quidem, inter eas tertia tamen differentia oritur.

8. Ibid. sect. 79. "Quand deux noms sont en construction, le terme antécédent se place après le terme conséquent, comme *ho toung*

fluvii oriens." E contrà verò in Othomiticâ linguâ. *Na me nsu*, mater virginis. Quarta hìc notanda differentia.

9. Ibid. sect. 80. "La règle précédente s'applique à tous les noms composés; ainsi l' on dit *thiân tseù*, cœli filius, hoc est imperator." Othomiti aliquandò hoc oppositum faciunt. *Mêti* Dominus divitiarum, id est, dives; *Mātè* amoris factor, id est *amans*.

10. Ibid. sect. 83. "Le substantif, sujet d'un verbe quelconque, ou complément d'un verbe actif, ne prend aucune marque particulière. Le premier se place avant, et le second après le verbe." Hoc etiàm in linguâ Othomiticâ accidit. *Na da i mā na nhò*, rex amat bonitatem, Indi, ut Sinenses dicunt. (Vide not. F.)

11. Ibid. sect. 84. "Le terme d' une action se marque par des prépositions différentes, suivant les idées d' ablation, d' addition, de séparation, ou de réunion qu'elle exprime;" id tàm apud Othomitos quàm apud Sinenses obtinet. (Vid. not. G.)

12. Ibid. sect. 93. "Il y a des mots qui par eux mêmes ont la signification adjective, tels que *tá*, magnus; *siaò*, parvus; *haò* bonus; *ngò* malus: quod apud Othomitos idem est, ut *da*, magnus; *tsi*, parvus; *nhò* bonus; *tsò*, malus.

13. Ibid. sect. 94. "D' autres sont des substantifs qui, joints à d' autres substantifs, expriment un attribut, comme *thiân ming*, cœli mandatum:" et hoc Othomiti etiàm proprium, ut *si thà* cortex patris, nempè avus.

14. Ibid. sect. 95. "Les adjectifs sont soumis à la règle des noms attributifs et se placent presque toujours avant le substantif auquel ils se rapportent, comme *ching jin*, sanctus homo: Othomiti semper adjectivum antè substantivum ponunt, ut *ka ye* sanctus homo.

15. Ibid. sect. 96. "Quelques adjectifs peuvent être pris comme verbes, et alors il arrive souvent que l'accent change pour marquer cette nouvelle acception, comme *hào* bonus, *haò* amare; hoc etiam in Othomi, *Hía* lucescit, *hià* dictum.

16. Ibid. sect. 98. "Tous les verbes forment des adjectifs par l' addition de *tchè*, comme *ssé* servire, *tchè ssé* serviens: quod addito *tè* Othomi præstant. *Pe*, servire; *pe tè* serviens.

17. Ibid. sect. 97. "Les adjectifs peuvent être employés comme noms abstraits; *tá* magnus, *thiân tá*, cœli magnitudo:" idem Otho-

miti, *da* magnus; *na da hetsi*, magnitudo extensionis in circùm, nempè cœli.

18. Ibid. sect. 100. "Le comparatif s' exprime par l'adjectif au positif, avec *iû*, *hian iû*, sapiens præ, sapientior." In Othomi idem cum *nra* habetur: *nhò* bonus, *nra nhò* melior.

19. Ibid. sect. 103. "Le superlatif se forme en plaçant avant l' adjectif un des mots suivans, *ki* summum; *chin*, valde, *tchi*, summè; *tsoúi*, multum:" apud Othomitos etiàm superlativum nomen, ex *tza*, *tse* multum, summum, antepositione formatur: *nhò, bonus; tza nhò*, optimus.

20. Ibid. sect. 119. "Les trois pronoms de la première personne, les plus usités anciennement, sont *Ngò*, *Ngoû*, *iù*." Triplex etiàm pro primâ personâ, Othomiticæ linguæ pronomen: *nga*, *nga-nga*, *ngwi*. (Vide not. H.)

21. Ibid. sect. 120, "Pour éviter le pronom de la première personne, on se sert quelquefois de son petit nom;" Othomitis etiàm, pronominis loco, humili utuntur nomine, si ad superiorem; autoritatis, si ad inferiorem; amicitiæ et benevolentiæ, si ad æqualem loquantur: ut, *ni betè bi ye wi*. *Ni*, tuus; *betè*, servitii factor, id est serviens; *bi*, ille, *ye*, obediet; *wi*, tibi; quæ omnia hæc significant: ego obediam tibi. *Ni tha i e wi*, tuus pater præcipit tibi; pro, ego præcipio tibi: *Ni be i mā wi*, tuus amicus amat te; id est, ego amo te. (Vide not. I.) Quem loquendi modum et Mexicani aliique Indi, Mexicanas habitantes terras habuerunt servantque: nec mirum; antiquis mos ille populis, ut Hebræis, fuit. (Vide not. H.)

22. Ibid. sect. 126—129. "Les pronoms de la seconde personne ne sont guère plus fréquemment usités que ceux de la première. Ceux qu' on trouve ordinairement dans les livres sont *eùl*, *joù*, *jo*, *tseù*; dans la langue moderne *ni* (sect. 317, p. 119)." Ab Othomitis secundæ personæ pronomen hujusmodi exprimitur: *hu*, vel *wi*, tu; *n-wi*, *nui*, *wi*, tu; nec major apud Indos, cùm ad superiores loquuntur, quàm apud Sinenses usus.

23. Ibid. sect. 132, "Le pronom de la troisième personne s' exprime par *khi*, *i*, ou *kiouei*, et *tchi*." Hoc in veteri sinâ; in novo verò, (Sect. 321, p. 122.) "Le pronom de la troisième personne est *thâ*."

Tertium Othomi pronomen est *nu*, *ni*, *wi*, vel *i*. *Bi* et *wi*, ille, et illi et illum significant.

24. Ibid. sect. 321, page 122. "Le pluriel se marque en ajoutant, après le pronom personnel ou l' appellatif qui en tient lieu, l' un de ces mots, *mên*, *mèi*, quilibet; *péi*, ordo; *ngò* ego; *ngò mên* nos:" quod de recenti Sinensi linguâ intelligi oportet, nàm in veteri, nil simile nobis apparet. Pluralis pronominum numerus ità apud Othomitos fit: primæ personæ additur *he*, ut *nga*, ego; *nga he*, nos: secundæ tertiæque personæ pronomen, si bis repetatur, pronomina pluralia habebimus. *N-we*, tu; *N-wewe*, vos; *hu*, tu; *n-wehu*, vos; *wi* tu; *nui* tu, *nuiwi* vos; *nu* ille; *ni* ille; *nuni* illi; *wi* ille; *nuwi*, illi. Aliquandò verò, quod illis singulare, id plurale.

25. Sinensis lingua possessiva pronomina non habet; Othomiti verò illis non carent: *ma* meus, *ni*, tuus, *na* suus. Quinta hic differentia inter illos habemus sermones.

26. Ibid. sect. 145. "Le pronom conjonctif, sujet de la proposition incidente, se rend par la particule *tchè*, placée à la fin de cette dernière." In Othomi verò *ta* vel *we*, antè incidentem posita, relativa pronomina sunt. Hic sexta (minima quidem) notanda est differentia.

27. Ibid. sect. 151. "Les verbes que les Chinois nomment *hō tseú* sont, comme les substantifs, de deux sortes; les uns toujours verbes par eux mêmes, et les autres alternativement verbes, noms abstraits, adjectifs, ou même particules, suivant la place qu' ils occupent dans la phrase, et les marques de rapports, qui peuvent s' y trouver attachées." Etiàm in linguâ Othomiticâ quædam verba suâ ex naturâ verba sunt, ut *te*, senire; *mā*, amare; alia verò et nomina substantiva et adjectiva, et verba et adverbia sunt: ut *nhò* bonus, *nhò* bonitas, *nhò* benè, *nhò* bonus esse. (Vide not. E.) Sed, non ex positione, sed ex particulis, in Othomi distinctio facienda; *na nhò*, bonitas; *sa nhò* bonus; *di nhò* bonus sum; *nhò*, benè: etiàm aliquando ex sensu vel positione, eorum natura cognoscenda; ut *ma nhò*, mea bonitas: *nu nhò ye* ille bonus homo: *di bùy nhò*, ego vivo benè. Undè neque hâc viâ tàm longè à Sinensi, Othomitus sermo est. Minùs enim erit, si animo illud advertimus, quod in recentiori Sinensi linguâ:

28. Ibid. sect. 302, page 113. "Les adjectifs (in novâ linguâ Sinensi) sont souvent accompagnés de la particule *ti*." Sic in Othomi

particula *sa*, aliaque conjunguntur. Ac præter dicta illa, ut in novo Sinâ ait Remusat, page 136, 137, esse signa temporum, et sic est in linguâ Othomitorum; hoc tamen discrimine, quod hæc in Sinâ tempus solùm, in Othomi et tempus et personam indicant; (Vide not. C.); quod cùm Othomitæ linguæ, suâ ex naturâ, minimè convenit, sed ab alienâ, ut jàm vidimus, probabilitèr ortum est. Septima hæc inter utrosque sermones differentiam adnotari meretur.

29. Ibid. 152, 153. "On a coutume de faire l' ellipse du verbe substantif, toutes les fois qu'il s' agit seulement d' attribuer une qualité à un sujet. Quand il s' agit d' attribuer plus positivement à un sujet une qualité qui emporte l' idée d' une action, on se sert du mot *wêi* qui peut se rendre par *être*." Hæc in Sinâ; in Othomi, duplici illo casu, triplicitèr fit; aut ellipsi oratio afficitur, ut *nga mêti*, ego dominus divitiarum; id est, ego sum dives; aut adjectivum particulis ad verbum transit, ut *di* vel *ga mêti;* aut *we* particulâ utitur; hoc rarò, tamen, *nga we mêti.*

30. Ibid. sect. 169. " L' adjectif verbal actif se forme par l'addition de *tchè*." Sic apud Sinas; apud Othomitos per *tè* additionem, ut non semel dictum est.

31. Ibid. sect. 170. Particula *khò* verba sinica passiva facit; quod verborum genus Othomiti non habent. Octava et hæc inter eas linguas enumeranda differentia.

32. Ibid. sect. 174. "Il y a des mots Chinois qui ont par eux mêmes le sens adverbial, soit qu' ils marquent des circonstances de temps ou de lieu." Et id Othomitica habet. (Vide not. K.)

33. Ibid. sect. 176. "On forme à volonté des adverbes, en ajoutant aux adjectifs ou aux verbes la particule *jân*, qui signifie *ainsi*." Omnia adjectiva apud Othomitos, adverbia sunt, cum loquenti placet: cognoscunturque in oratione, sive eorum ex positione, sive ex *thò*, (omne) nominis additione.

34. Ibid. sect. 177. "Comme les adjectifs et les autres noms attributifs se placent ordinairement avant le sujet auquel ils tiennent lieu de qualificatifs, de même les verbes et les expressions simples ou composées, modificatives ou circonstantielles, ont coutume de précéder le verbe dont ils spécifient l' action. Cette observation fait voir comment des substantifs ou des verbes peuvent être pris adverbialement, d'après

la place qu' ils occupent dans une phrase, et sans qu' il soit besoin d' aucun signe particulier." Quid simile Othomi habet: *homo benè loquitur;* ita reddi potest hæc oratio: *ye hia nhò; ye*, homo; *hia*, loquitur; *nhò*, benè, aut bonum: *ye nhò hia; ye*, homo; *nhò*, bonus; *hia*, loquitur: homo bonus est (dùm) loquitur. Sed frequentiùs adverbium, verbum modificans illi postponitur, ut primo viditur in exemplo.

35. Ibid. sect. 179. "Les prépositions proprement dites veulent en général être placées immédiatement avant leur complément." Hoc ipsissimum in Othomi evenit.

36. Utraque earum lingua conjunctivis eodem utitur modo.

37. Ibid. sect. 371. "Les interjections les plus usitées sont au commencement de la phrase." Hoc in Sinico recentiore; et illo etiam in loco in Othomi collocantur interjectiones.

38. Ibid. sect. 284, page 107. De recentiore linguâ iterùm, Remusatius dicit: "Pour obvier aux inconvéniens qui resulteraient, dans la langue parlée, de la multiplicité des termes homophones, et des mots qui peuvent être pris comme verbes ou comme substantifs, on y fait fréquemment usage de mots composés, lesquels sont formés d'après divers procédés. Les plus communs sont formés de la réunion de deux termes synonymes, dont l' un n' ajoute rien au sens de l'autre, mais sert seulement à le déterminer, parce que l' équivoque, possible à l' égard de chacun d' eux en particulier, ne l' est pas à l' égard du mot dissyllabique qui resulte de leur groupement."

Hoc etiàm apud Othomitos componendi artificium invenitur; ità tamen, ut non nisi cùm dubii et æquivoci periculum est; itaque si dixero *di ne de*, impossibile est ut quo ego indigeam intelligatur. *De* enim, et aquam, et ovum, et vestem significat. *Di ne* opto; *de*, et aquam, et ova, et vestem? Hac de causâ, dicitur, *dehe; he* frigus, et frigidum significat; *ye* longus, *deye* vestis est; et ità ferè omnia nomina: sed inter Othomitos secundum nomen, non nisi quandò equivocum fieri potest pronuntiatur. Itaque non dicam *di tsi dehe* ego bibo aquam, sed solùm *di tsi de*, quia nec ova, nec vestem bibere possum.

En quidem totius hujus Indianæ linguæ inextricabilem labyrinthum, à quo vix sese liberare potuerunt qui de hujus linguæ grammaticâ instituêre. Hoc tamen intellecto, facillima illa, et pulchra etiàm apparet, lingua, et ab antiquis Mexicanis, et à novis, tamquam barbara despecta, ab exteris ignorata, aut incognita.

39. Quem quidem ad modum nomina componuntur, ità etiàm verba, utrâque in linguâ composita sunt: Sic Remusatius de recentiori linguâ Sinensium, sect. 343 p. 130, loquitur: "On réunit fréquemment ensemble deux verbes synonymes ou très analogues dans leur signification, comme cela a lieu pour les substantifs, et par le même motif." Ità apud Othomitos etiàm fieri ex primâ parte hujus operis vidimus; hæc tamen cognoscenda differentia, quod à quibusdam Othomitis, hoc solùm ad imperativum formandum præstatur, ab aliis omnibus id temporibus servatur. Quare, et ipsi scriptores eum sequuntur usum, quem apud diversos Indorum pagos invenerunt. Andreas Olmas,* qui religionis elementa in Othomi, sæculo decimo sexto, explanavit, dissyllabicis loquitur verbis; Ludovicus de Neve et Molina,† unicâ ea syllabâ conjugabat; Yepes,‡ priusque illo Ramirez,§ eos audierunt Indos, qui magistrum habuerunt, eumque Andreas Olmas. Itaque, quidam Indi dicunt, *di mădi*, ego amo: alii vero *di mă: mă* enim amare, et *di* exequi, est. Mirum quidem, tamen certum; in Othomi et veteris et novi Sinensis vestigia inveniuntur. (Vide not. T.)

40. Præter ea, in novo Sinensi imperativo nulla particula est, et id etiam in Othomi.

41. Ibid. sect. 358. "L'impératif quand on parle à des inférieurs s' exprime en mettant le pronom de la deuxième personne avant le verbe;" in Othomi tamen, licet eadem sit, hæc verbi forma, pronomen aut anteà aut posteà ponitur.

42. Ibid. sect. 359. "Par urbanité on fait ordinairement précéder l' impératif du mot *thsing* qui signifie prier, inviter." Othomiti imperativo verbum *sa*, placeat, vel *da* concede, anteponunt.

* Oraciones y Doctrina Cristiana, en Lengua Otomi. Mexico 15—. Hoc opus in Bibliothecis civitatis Philadelphiæ non invenitur.

† Reglas de Orthographia, Diccionario y Arte del Idioma Othomi; breve instruccion para los principiantes, que dictò el L. D. Luis de Neve y Molina, Catedratico, &c. Mexico, 1767. In Bibliothecâ Societatis Philosophicæ Americanæ.

‡ Catecismo y Declaracion de la Doctrina Cristiana en lengua Otomi, compuesto por el R. P. Fr. Joaquin Lopez Yepes, Predicador apostolico, &c, Megico, 1826. In Bibliothecâ Dni Duponceau.

§ Ramirezii opus Philadelphiæ non invenitur.

43. Ibid. sect. 367, p. 141. "On fait fréquement usage (in novo Sinâ), d'adverbes composés, soit de la répétition d' un même mot, soit du groupement de deux verbes synonymes." Id ipsissimum apud Othomitos contingit. (Vide not. K.)

Nil momenti hâc de re omissum credo; ferè quidem totum Remusatii opus doctissimæ societatis ob oculos posui. Octo solùm ex capitibus hæ duæ linguæ discordant; in aliis plerùmque concordes esse videntur. De numeris nil diximus, quia nulla inter utriusque linguæ numeralia nomina existit affinitas in sonis (Vide not. L.) Quod evidentèr probat Othomitos illa nec à Mexicanis, nec à Huastecis accepisse. Quid hoc sibi vult ignoro ego, et ingenuè fateor; fortassè cùm aliâ dissertatione, de hujus linguæ historiâ agam, conjecturis investigare aliquid licebit.

Sed fortassè quærendum est, utrùm nulla in utriusque linguæ verbis, ut in grammaticæ formis, et linguarum naturâ cognatio? De hoc judicent alii; præsertìm quia linguæ Sinensis vera pronuntiatio nunquàm meas pervenit ad aures; aliqua tamen verba vobis offero, ex Remusatii grammaticâ fidelitèr extracta, quæ cum analogis verbis Othomiticis juxtà positis, comparare poteritis; quod difficillimè fiet ignotis vocalium sonis, qui litteris exprimi nequeunt; accentus, aliaque signa paulùm adjuvant. Qui voces Sinarum Othomitorumque non audierunt, haud facilè de similitudine inter sonos earum judicare possunt. *Ou* Gallicum hìc stat in Othomi pro *u* Hispanico.

Sinicè.	*Othomiticè.*	*Latinè.*
Cho	To	Qui.
Y	N-y	Plaga.
Teou	Gou, Mou	Caput.
Siao	Soui	Nox.
Tien	Tsi	Dens.
Ye	Yo	Lucidum.
Ky	Hy	Felicitas.
Kou	Dou	Mors.
Po	Yo	Non, ne
Na	Ta	Masculus.
Niu	Nsou	Femina.

Sinicè.	*Othomiticè.*	*Latinè.*
Tseu	Tsi, Ti	Filius.
Tso	Tsa	Perficere.
Touan	Khouani	Verus, verè.
Siao	Sa	Irridere.
Pa	Da	Dare.
Tsoun	Nsou	Honor.
Hou	Hmou	Dominus.
Na	Na	Ille, a.
Hu	He	Frigidus, frigus.
Mian	Hmi	Vultus.
Kouei	Ekhoua, Koua	Diabolus.
Kou	Ko	Vetus.
Si	I	Dolere.
Y, Medicus	I	Medicina.
	Te i medicinæ factor	Medicus.
Kian	Hia	Videre.
Kou	Mou	Dominus.
Ye	He	Et.
Hoa	Hia	Sermo.
Man	Ma	Plenus.
Kho	Nho	Dignus.
Khi	Stsi	Comedere.
Tsoui	Tsi	Ebrietas.
Jin	Ye	Homo.
Ka	Rsa	Audere.
Ngo	Nga	Ego.
Ni	Ni	Tu.
Tha	Na	Ille.
Ti	Te	Quod, quid?
Ti	Toa	Qui, quæ.
Te	Tsa	Posse.
Lou	You	Iter.
Sie	Tsi	Paucus.
Khiu, Lai	Ehe, yehe	Venire.
Hao	Nho	Bonus.

Sinicè.	*Othomiticè.*	*Latinè.*
I	Moui	Animus.
Ta	Da	Magnus.
Li	Ti	Lucrum.
Pa	Pa	Capere.
Pa	Da, ma, na	Dimidius.
Ho	To	Quis.
Mai	Ma	Emere.
Pa	Pa	Desinere.
Mou, Mo	Me	Mater.

Qualis ille Othomitorum populus, ex ejus linguâ, aliâ dissertatione, Deo volente, unà mecum judicabitis. Nunc verò, ut quanti philologia sit facienda magis ac magis cognoscatur, pauca de illo dicenda. Deum Optimum, Maximum, sublimi nomine appellabant. *Okha* nempè; *O*, recordari, et *kha*, sanctus, divinus. *O* etiam apud eos, præsenti tempore, aliquid cognoscere significat. Si illud nomen non tàm magnificum ut quo Tarasci Deum cognoscebant, nempè *Avanda* (Ratio personificata), sine dubio tamen, et Mexicano *Teotl* (princeps, excelsus), et Quichuano *Capac* (dives) sublimius est. Licet cœli nomine, non felicitatis locum, ut *Ilhuicac* Mexicanorum, nec rationis domum, ut *Avandaro* Tarascarum, intelligant, tamen *Mahētsi* (latitudo, et extensio in circùm), illud vocant; nàm hominem immortalem credebant. Nullus enim, quod sciam ego, ex Indorum Mexicanas habitantibus terras, populus, qui hanc doctrinam, humanitatis solatium, virtutis adjutricem, criminisque extirpatricem et terrorem, pro religione non haberet. O! eum virum philosophiæ amantem beatum, cùm generis humani traditionem hanc ille, hic et ubique terrarum diffusam invenit! Othomi enim, *sudi*, nempè mortuorum umbras vel manes, religionibus, ut Huasteci *elot* suos, placabant. Nil tàm solemne Othomitis quam commercium inter cœlum et terram credere. Illi enim et incantatores venerabant, eosque *Yēkha*, manus sacra (potestas superior) appellabant. Illis, idem sapiens qui Magus; undè uno utrosque nomine *Bādi* cognoscunt, quod et Huastecis commune, quibus *Huitom* et sapiens et Magus est. Cujus in memoriam non et eadem multorum Asiæ populorum consuetudo venit, et cùm *extensionem* cœlum vocare audit, non sublimem illius canentis sententiam "extendit cœlos sicut pellem" recordatur?

Prætereà, Othomiti Diabolum, mali principium auctoremque habebant; eum *ē*, (maleficum) dicebant; nescio adhùc tamen, utrùm illi, ejus ministros, quive illi fuerint, ut Mexicani, qui Bubones (*Tecolotl*), Bubonum duces, *Hacalecolotl*, i. e. Diaboli, hominum generi quod voluntatem pessimam, infensam, interpretes significare adjudicarunt, pertimerent.

Nulla usque ad præsens, in Othomitorum linguâ vestigia, ut cognoscamus, utrùm Indi isti cœlum terramque animatos, ut Mexicani, cogitabant; neque illud invenire possumus, an ut Tarasci Huastecique, Astra, Laresve, quod eorum ex linguis, licet id historia ignoret scimus, adorarent. Othomiti enim Solem, *Hiadi*, (lucescere, lux), dicebant; diem *Hiatzi*, (lux paulatim veniens); stellas verò *tze* (fulgentia corpora) et lunam *rzana* (corpus rotundum in dimidias partes divisibile), et istius cursû menses numerabant.

Populus ille numerabilis, quia parvus erat; ut de alio Horatius cecinit, eorum ex paucis sunt, qui non sese matrimonii fœdere cum aliis Indorum, Hispanorumve, vel Africanorum nationibus miscuerunt. Eorum paupertas, miseria et ignorantia, non minores quam abhinc tribus sæculis fuerunt; eorum lingua, sine dubio, ad multa de iis est illis in causâ. Faxit D. O. M. ut illi meliora habeant!

Olìm quidem, eos qui ad Deum è medio tollendum ad barbarorum testimonium appellabant, ad barbaros, irrisionis ergò, Ludovicus Racine, poëta Gallicus, relegabat. Viveret nunc, et philologia eum, miris de rebus quæ inter barbaros invenire ac detegere potuit, docuisset, certè, barbarorum judicium iste non recusasset, illique ab eo damnati ex tunc non fuissent. Sapienter Verulamius, scientias omnes germanas sororesque, et ab uno omnes illas arbore ramos pronuntiavit, et hoc philologia satìs probat.

Appendix.

Licet ulteriùs et temporis et operis, de Othomiticæ linguæ scriptorum historiâ instituere mihi sit in animo; quædam, tamen, non multa quidem, nunc temporis consideranda sunt.

Atque in primis, ut meliùs quod à me scriptum est, judicari, examinarique possit, ea animadvertenda sunt. Verba quæ duplicem syllabam habent, quibusdam Othomitis ab Indis, duplici syllabâ conjugari, ut nunc fit in Tzecu, et videre est in Joachimi Yepes opere; ab aliis verò, ut Xilotepec degentibus, unâ tantùm syllabâ, excepto imperativo, conjugari, quod Ludovicus de Neve y Molina docet: deindè Lexica illa ità multa nomina scripsisse, ut quæ, cùm monosyllabica sint, dissyllabica appareant, quia ex nomine et particulâ unum nomen coalescunt et formant, ut ex *sa*, vel *xa*, adjectivi signum, et *nhò* adjectivum nomen, *bonum* significans, *sanhò* vel *xanhò* effecerunt. Et hâc de causâ, dicunt illi scriptores, multa in verbis aut nominibus, aut elici aut supprimi, per syncopen, aliasque figuras.

Deindè, illud evenit, ut ità Othomitam Grammaticam explanarent, ut qui vellent omnia per Nebricenses linguæ Latinæ institutiones docere. Quid mirum? An non idem in suâ de Sinensi linguâ grammaticâ Pater Varo effecit? Sed, possibile ne est, ut monosyllabicam illam Othomitorum linguam esse, illos scriptores fugisse? Ità fuit ut multos de Sinensi scriptores, mandarinum inter et vulgarem sermonem distinguere fugit; primus enim qui distinctionem illam animadvertit, Pater Prémare fuit. Non enim antiqua tempora nostris judicanda sunt. Quare, adhùc genuina veraque Othomiticæ linguæ grammatica desideratur. Faxit enim D. O. M. ut in alicujus Mexicani mentem voluntatemque veniat, ut opus illud aggrediatur! Facilè, optimèque ille sese expediet, si Sinensis Remusatii grammatices vestigiis adhæreat. Multi enim, ex meis concivibus, ad id et ad alia etiàm majora apti, capaces que sunt. Nec enim nobis desunt viri qui Confucium legunt, intelligunt que, neque illa Mexicanorum ignorantia tanta est, ut quidam, qui Mexicum neque geographicis chartis viderunt, prætendere audent, et quidam Mexicani degeneres, (pudet id!) venditant. Quo id consilio, nescio, illi scient; fortassè, id volunt dicere quod Pharisæus prædicabat: "Non sum sicut cæteri homines." Eheu! quanta meæ miserrimæ patriæ infelicitas! Tempus tamen erit, cùm magna illa natio vocabitur habebiturque.

Cùm enim illa ità se habeant, mirum non est de Othomiticâ linguâ scriptores, sapientes multos fefellisse. Quo enim modo isti viri rectè de linguâ judicare possent? Hâc de causâ et Abel Remusat illud statuit, omnes linguas scripturam non habentes, in mutationes, compositiones, derivata que affluentes et abundantes esse; Petrusque Duponceau, in hâc Septentrionali Republicâ Americanâ, Indianæ litteraturæ pater, meusque magister, omnes Indianas linguas polysyntheticas pronuntiavit. Abel Remusat, Petrusque Duponceau; qui illi viri, Deus optime! Quis enim illos, nostræ ætatis ornamenta, litterarumque columina, ignorantiæ accusare audeat? Illi quod scripserunt alii judicarunt; quod illi scribere debuissent, divinare humanitùs non potuerunt.

Quod eò quidem tendit, ut nemo me, sex lustris natum, litterarumque tyronem, impudentem audacemque habeat, illud agitans, me ut illis meis magistris, (utinàm eos ità appellare non demerear!) contradicam, scripsisse. Hoc enim et mihi et meo Mexico debeo. Præterea veritati, gratitudini, et illius debitor sum, ut animadvertam et Petrum Duponceau viam mihi ad hoc scribendum indigitasse, et librorum et magistraturæ copiam fecisse, ac ipsum tandem, ipsissimum, Societati Philosophicæ Americanæ meum utcunque opusculum, luci mandandum commendasse. Nescio enim, utrùm senex ille, quinque suprà septuaginta annos natus, suâ scientiâ, aut suâ hâc bonâ fide major appareat. Hoc quidem illi solùm faciunt qui veritatem quærunt et amant.

Ut meliùs intelligatur natura, structuraque istius linguæ Othomiticæ, Anacreontis Oden undecimam, in illam vertere ac scholiis illustrare tentavi; quæ versio invenietur in annotationibus, sub literâ M, quâ cum fiet conclusio hujus operis.

Annotanda.

A.

In hâc annotatione, quædam homophona, vel ferè homophona verba, exempli gratiâ adhibentur.

Vocalium litterarum nasalem sonum hoc signo (–) designabimus; gutturalem illo (ˋ): protractum, qui dicitur ovillum et solùm ad litteram *e* pertinet, illo (^). *O* longum aliquandò signo *ò*, vel Gallico modo litteris *eau*, (ut *nheau* vel *nhò*, bonus) notatur. Soni naturales signis non indigent. Cæteri verò nec litteris, nec signis, nec ullo quidem modo oculorum operâ, auribus eorum qui hanc linguam non audiêre, præstari possunt.

A.

A meta; scopum attingere.
A (à) respirare; vigilare; à somno revocare.
A (ā) dormire; profundus; profunditas; fovea.

B.

Ba uti; usus; mamilla; uber; lac.
Bà gignere; genitus; filius; cognatus (Gallicè *parent*, Anglicè *relation*); vendere.
Bā scire.
Bay stare; morare; vivere; arbor.
Be furari; fur; à viâ rectâ deflectere.
Bè tela.
Bê agnatio; cognatus.
Bi timere; tremor.
Bì sub; infrà.
Bu insufflare.
Bùy habitare.

D.

Da magnus; decoctum; digerere.
Dà semen; maturari; maturus; robustus; appositus.
Dā oculus; dux; unire.
De ovum; aqua; vestis; operire.
Dè ardere; senire; jugum; accensus.
Dē facere.
Do sine; carere; lapis.
Du *vel* tu mori.

G.

Gà ego, me, mihi.
Go Dominus; Domina; go thà, Domine Pater.

H.

Hæc littera semper gutturalis ut *x* et *j* Hispanum, et *ch* Germanorum antè *a* et *o*.
Ha tollere; portare; debitum.
Hā et; prohibere.
Hày terra.
He vestis; aqua; speculum.
Hè glacies; gelidum; frigus; frigidus.
Hê mons; fingere; fictor.
Hèy ludere; excavare; veneri operam dare.
Hi sonare; ordiri; texere.
Hī aliquid.
Hia inquirere; sermo; aspirare; lux.
Hiā cuniculus.
Hiaê turpis; spectare; pandiculari.
Hie speculum.
Hiè antè; suprà.
Hin non.
Hing facilis.
Hio latus; decipi; occidere.
Hmi facies.
Hmu Dominus.
Ho blandire; occidere.
Hog dulcis; honestus; probus; nobilis actionibus (Anglicè *gentleman;* Gallicè *homme comme il faut*).

Hu nomen; nominare; clibanus; fornax.
Hù uti.
Hua ala.
Hùa piscis.
Huy stabilire; ponere; accedere.

I.

I venerabilis; dexter, a, um.
I (ì) dolor.

K.

Ka sese inclinare; gignere; laborare; uti; exercere.
Kay cubare; lectum petere.
Ke, ki, khi venerabilis. *Thà khy* vel *Thà-y*, Pater (venerande Pater).
Kha accipere; adesse; in; apud; habere; evenire, accadere; arripere.
Kho colligere; possidere.
Khò abesse.
Khu manu prehendere.
Ki venerabilis; removere.
Kè me; mihi; tollere; plumas evellere; excoriare.
Ko strepitum facere; sonare; cadere; imago.
Koy repræsentare.
Ku levis.
Kuo (monos.) ira; irasci; iratus; via, (cujusque rei spatium quo alia induci potest.)
Kuy (monos.) sapere; sapor; aliquid facere; currere.

M.

Ma emere; vendere; dic; portare, afferre, latus, a, um; excellens; multus, a, um; præteritus; *Ma he*, mei, æ, a, in plurali numero; *he* significat *nos;* itaque sensus est *meus nos;* ut *ma thà he*, mi pater nos; i. e. pater noster.
Ma idem ac *na*, articulus nomen substantivum designans. Quibusdam in locis *ma;* in aliis *na* dicitur. *Ma* vel *na* etiam significat medius, a, um.
Mà displicere; fastidiri; repleri; plenus.
Mài palmex; tradux.
Me non coctus, a, um.
Mè durus, a, um.
Mē mater.
Mê spissare; densare; cujusque rei dominus; *mê ngu*, habitator domus.
Mi facies; sedere; requiescere; proper; unus post alterum successivè.
Mì nasci; summus, a, um; cujusque rei extremum.
Mia (monos.) lectus; grabatus.
Mo curvus; flectus; flectere.
Mu avunculus; levis.
Mùy (monos.) cor; anima; animi indoles; nudus, a, um.

N.

Na unus, a, um; ille, a, ud; articuli vices gerit.
Na *et* ra unus, a, um.
Na *et* ma medius, a, um.
Naê (monos.) insulsus; inconditus.
Này (monos.) jacere.
Nbò intus.
Ndò os, ossis; grando, inis.
Ndu ardere.
Ne acies.
Nè os, oris; ambulare; movere.
Nê montis radix.
Neā (monos.) qualis, e.
Nêy (monos.) saltare; saltator.
Nga* spica; spicos colligere.
Ngà suavis; remissus.
Ngā *vel* ngāgā *vel* ngwi Ego
Ngò festivus.
Ngu spica; domus; mus; ut; secundùm; juxtà.
Ngwê *vel simpliciter* ê caro.
Nhāg infrà; post.
Nhê cunabula.
Nhey difficilis.
Nhêy profundus.
Nhi lavare se ipsum; balneum accipere; vestiri.
Nhie speculum, scilicet *hie* cum articulo *na* præfixo.

* Potiùs quam littera sonus hic *ng* putandum est intonatio, et sic scribi posset 'a, 'e, 'i 'o 'u.

Nhiu gravis.

Nhò bonus; pulcher; aptus; perfectus; justus; urbanus, aliaque innumera, ut suprà dixi. Hoc verbum hìc aliquando scribitur *nheau*, orthographiæ Gallicæ quam in inceptu hujus operis eligebam, et maximè sequutus sum gratiâ. Observandum est tamen quod *u* et *eu*, sonos linguæ Gallicæ in hâc linguâ non inveniuntur. Ergò littera *u* semper Italico vel Hispanico more pronuntiari debet, *ai* et *ay*, semper duplici sono, *aï*.

Nkhū amare.

Npa calefacere.

Nrsài assuescere; evenire; aptus, a, um.

Nsā *ac* Niā fœtidus; corruptus.

Nsu (monos.) fœmina; fœmineum; nox esse.

Nsù nutrix.

Nsū, virgo; virginitas; honor; verecundia.

Nsuy (monos.) nox.

Nto vagina; operire.

Ntsāy (monos.) platea.

Ntso malus; turpis; fœdus; deformis.

Ntù os, oris.

Nu videre.

Nua (monos.) iste, a, ud.

Nùa (monos.) annuntiare; novitas; novus.

Nūy (monos.) tu.

N Hispanicum, quod scribitur ñ, et ut *gn* Italicum et Gallicum sonat.

Na (ña) loqui; exaggerare.

Nà (ñà) crudelis; absconditus etiam particula negativa, quasi *in* apud Latinos, ut bādi, sapiens; ñabādi, ignorans, non sapiens.

Nā (ñā) caput.

Nêy (ñêy) medicus.

Nu (ñu) plenus; iter; via.

O.

O inimicus; recordari; recordatio.

O camera; cubiculum.

P.

Pa vendere; notare; sapor; dies; quodcunque temporis spatium.

Pà febris.

Pe exerceri; texere.

Pê pellucere.

P'he furari, fur.

P'hê gubernare; gubernator.

P'ho sordidus; scire; cognoscere.

Pong curvus; arctus; angustus.

R.

Ra æqualis; similis.

Rè columna.

Rsa asseverare; obtinere; sanare; assuescere; periculum facere.

Rsa lignum.

Rsè carere.

Rsê ardere; accendi; ignem facere; adorare.

Rsi manducare.

Rū dulcis.

S.

Sa unguis; manè; madefactus; humiditas; protegere; objurgare; extrahere; aquam haurire.

Sā benevolus; benevolentia.

Say terminare, finire.

Se frustum.

Sē pars; frustum.

Sê deformis; non pulcher; auctus; impetus. Aliquandò præpositio, quæ antè illius nomen vel descriptionem, cui utilitas vel damnum est, ponitur; *Mahêntsi sê nhò*, cœlum justis.

Sey foramen; aperire; excavare.

Si planus; color; crusta; folium; extendere; cutis; etiàm particula interrogativa, ne, numquid?

Si clamare; clamor.

So latus, extensus.

Stà capillus.

T.

Ta albus; masculus.

Tāi emere.

Tchi humerus.

Te quis? quid? ut? quomodo?

Tè vivus; creare; facere.

Tê crescere; altus; nobilis.
Tes aliquis; aliquid.
Têi pascua; palea.
Thà pater.
Thāi debere; pharetra.
Ti ebrius, bibere usque ad ebrietatem; offuscare; confundere.
To herba; virga; tegmen.
Toò qui, quæ, quod. Si relativum rationalis rei nomen repræsentet, melius est uti pronomine *wê*, quod vide.
Tsa merè; propriè; sanare; salutem habere; cuspis; intùs; interior; acutus; divisus.
Tsà *vel* Tse multum.
Tsà placere.
Tse planta; multum.
Tsè frigus; frigidus.
Tsê redire.
Tsi *vel* Ti parvus; germen novum, surculus; dens; cujusque rei extrema pars; concio; in concionem vocare,edere.
Tsī minuere aliquid; stridere.
Tso parvi pendere; sese præcipitem dare; profundere.
Tsu timere; timor; succum extrahere.
Tū *vel* Dū mori.
Tù horreum.

U.

U sal; nunc.

W.

Wa piscis; hìc (adv.)
Wae perdere; amittere.
Wày descendere.
We avunculus; viscus, eris.
We, weā æqualis.
Wè tu.
Wê qui, quæ.
Wey præparare.
Wi tu; simul.

Y.

Ya hepar; plaga; ulcus; pus.
Yā virga; aperire; viam in montibus facere arbores secando.
Yai irrigare; aquam profundere.
Ye operam dare; pluvia.
Yé viridere; homo; malitia; perversitas; exsiccari.
Yê manus; admirare; stupefieri.
Yo non, ne (vetantis); ut *Yo êdê*, cave ne audias.
Yo lumen; extendere; inferior; grex; agnus; lana; tegere; ambulare.
Yù rugire; radix; via; iter facere; res.

Z.

Za rotundus; rotunditas; arcus; arcum ædificare.
Zà lignum; ligna secare.
Ze parvus.
Zo cadere.
Ztsa posse.
Ztsi seligere; bibere.
Ztso *vel* Ztsa experiri.

B.

VERBORUM COMPOSITIO.

Dàmē	Dà, *maturus*	Mē, *mater*	Vir, maritus.
Dànsū	Dà, *maturus*	Nsū, *fœmina*	Mulier, uxor.
Tinsū, vel Tzinsū	Ti, vel. Tzi, *surculus*	Nsū, *fœmina*	Filia.
Bàtzi	Bà, *genitus*	Tzi, *surculus*	Filius.
Sithà	Si, *cortex*	Thà, *pater*	Avus.
Mêti	Mê, *dominus*	Ti, *divitia*	Dives.

Tasi	Ta, *alba*	Si, *superficies*	Argentum.
Kasti	Ka, *flava*	Sti, *superficies*	Aurum.
Hētsi	Hē, *distensum*	Tsi, *in circùm*	Circumdans.
Mahētsi	Ma, *latum*	Hētsi, *circùm distensum*	Cœlum.
Sāhi	Sā, *benevolens*	Hi, *interior*	Amica (in malam partem).
Hogkhai	Hog, *dulcis*	Khai, *gens*	Homo bonæ indolis.
Sikei	Si, *pellis*	Kei, *corpus*	Cutis.
Mohe	Mo, *terræ præruptum*	He, *aqua*	Lacus.
Dahe	Da, *multa*	He, *aqua*	Flumen.
Ehmi	E (ē), *iratus*	Hmi, *facies*	Inurbanus homo.
Yohmi	Yo, *duplex*	Hmi, *facies*	Perfidus.
Meti	Me, *carens*	Ti, *bonum, divitiæ*	Mendicus.
Ethò	E (ē), *perfectum*	Thò, *omne*	Pulcherrimus.
Sine	Si, *folium*	Ne, *os*	Labia.
Kuane	Kua, *apud*	Ne, *os*	Lîngua.
Yuhe	Yu, *via*	He, *aqua*	Aquæ ductus.
Nehia	Ne, *os*	Hia, *verbum*	Loquax.
Pche	Pe, *scaturire*	He, *aqua*	Fons.
Datsū	Da, *floridus*	Tsū, *fœmina*	Puella.
Hêmē	Hê, *fingere*	Mē, *mater*	Matertera.
P'hoyê	P'ho, *ornare*	Yê, *manus*	Annulus.
Thūgū	Thū, *pendere*	Gū, *auris*	Inauris.
Dodo	Do, *petra*	Do, *petra*	Stultus.
Dogua	Do, *petra*	Gua, *pes*	Claudus.
Gàwi, vel Wàwi	Gà, *strepitus*	Wi, *simul*	Bellum.
Godā	Go, *petra*	Dā, *oculus*	Cæcus.
Hiadi	Hia, *lucere, lux*	Di, *efficere*	Sol.
Hiatsi	Hia, *lucere, lux*	Tsi, *facere*	Dies.
Thūdo	Thū, *occendere*	Do, *lapis*	Cos.
Widā	Wi, *succus*	Dā, *oculus*	Lacrymæ.
Ngêtsi	E (ê), *caro*	Tsi, *dens*	Gingiva.
Ngêde	E (ê), *caro*	De, *operire*	Muliebris cyclas usque ad talos.
Zana	Za, *rotunda*	Na, *dimidia*	Luna.
Razana	Ra, *una*	Zana, *luna*	Mensis.
Sithò	Si, *folium*	Thò, *omne*	Vitrum.

Hâc viâ, omnia nomina composita distingui separarique possunt. Verbalia verò cùm sint, ex imperativi secundâ personâ composita sunt, ut *bādi,* scito; *bādi,* scientia; *bādi,* sapiens; vel verbum cum *tè* facere. De illis in annotatione quæ immediatè sequitur. Alia verò composita sunt, non quod sensum habendum quæratur, sed ad vitanda æquivoca, ut *ye* homo, *he* gignere, *yehe* homo; *de* aqua, *he* frigus, *dehe* aqua; *tsi filius*, *ba* genitus, *batsi* filius, quod quidem aliàs explicabitur.

C.

MODUS CONJUGANDI.

Diversimodè verborum imperativi persona secunda formatur ; aliquandò *tè* verbo, ut in sequentibus nunc conjugandis.

Di tè, *ego facio,*	Tètè, *facere facere,* id est,	Fac.
Gui hê, *tu corrumpis,*	Hêtè, *corrumpere facere,*	Corrumpe.
Y kue, *ille conglutinat,*	Kuetè, *conglutinare facere,*	Conglutina.
Di hê, *nos fingimus,*	Hêtè, *fingere facere,*	Finge.
Gui tza wi, *vos murmuratis,*	Tzatè, *murmurare facere,*	Murmura.
Gui we hū, *vos apponitis,*	Wetè, *apponere facere,*	Appone.
Y te yū, *illi lambunt,*	Tetè, *lambere facere,*	Lambe.

En præsentis temporis artificium. *Di, qui, y* vel *i,* particulæ, tempus et personam unà indicantes. *Wi* nos; *qui** et *wi* vel *hū* vos, *yū* illi significant. Videtur ergò quomodò hæc verba monosyllaba sunt.

Quædam verba cum verbis *tza, tze* imperativum formant. Frequentiùs tamen in *tzi* verbo illud desinit. *Tza* posse et evenire; *tze* efficere et virtutem habere; *tzi* ferre significant.

EXEMPLA EX TEMPORE PRÆTERITO.

Da sāi, *extraxi,*	Sāitza, *extrahere posse,* id est,	Extrahe.
Ga hê, *coxisti,*	Hêtze, *coquere efficere,*	Coque.
Bi ê, *odiit,*	Etza, *odisse evenire,*	Odi.
Da gūe he, *præimus,*	Gūetzi, *præire ferre,*	Præi.
Ga hiū wi, *posuistis,*	Hiūtzi, *ponere ferre,*	Pone.
Ga sa hūn, *evulsistis,*	Satzi, *evellere ferre,*	Evelle.
Bi te yū, *ascenderunt,*	Tetze, *ascendere virtutem habere,*	Ascende.

Da, ga, bi vel etiam *Xta, Xa, Sta, Sca, Sa,* præteriti perfecti particulæ sunt. Sic idea temporis ideæ personæ jungitur.

Alia verba imperativum cum verbis *ni* exigere; *ni* germinare; *hi* intùs esse; *hi* introire, componunt.

EXEMPLA EX PLUSQUAM PERFECTO.

Sta hiū hmā, *fragraveram,*	Yuni, *fragrare germinare,*	Fragra.
Sta yê hmā, *curaveras,*	Yêhi, *curare introire,*	Cura.
Sa mê hmā, *meritus erat,*	Mêni, *mereri exigere,*	Merere.
Sta p'hè hmā, *cogitaveramus,*	P'hèni, *cogitare germinare,*	Cogita.
Sca ê hmā wi, *malefeceratis,*	Ehi, *malefacere intùs esse,*	Malefac.
Sca dē hmā hū, *florueratis,*	Dēni, *florere germinare,*	Flore.
Sa cū hmā yū, *gustaverant,*	Cūhi, *gustare intùs esse,*	Gusta.

* *Que, qui,* semper pronuntiari debent ut *ke, ki.*

Sta, sca, sa, hmā plus quam perfecti particulæ sunt, tempus et personam indicantes.

Aliquandò verò, imperativi persona cum verbis *ti* vel *di* formatur, et hic est frequentior usus. *Ti* et *di* expedire, exequi, pervenire significant.

EXEMPLA EX PRÆTERITO IMPERFECTO.

Di ña ma, *promittebam,*	ñati, *promittere exequi,*	Promitte.
Gui hmà hmā, *manifestabas,*	hmàdi, *manifestare exequi,*	Manifesta.
Y nè hmā, *calcabat,*	nêti, *calcare exequi,*	Calca.
Di ā nmā he, *petebamus,*	Adi, *petere exequi,*	Pete.
Gui mā hmā wi, *amabatis,*	Mādi, *amare exequi,*	Ama.
Gui tzū hmā hū, *assequebamini,*	Tzudi, *assequi expedire,*	Assequere.
Y hia hmā yū, *videbant,*	Hiadi, *videre exequi,*	Vide.

Gui, y, di, hmā, præteriti imperfecti particulæ, nil per se significantes.

Quamplurima verba, alio verbo, non multùm dissimili significatione, imperativum componunt; alia etiàm nomine, alia adverbio, aliquandò modum, aliquandò effectum vel causam exprimentibus; sed hæc nomina et adverbia etiàm verba sunt et ut verba reddi possunt.

EXEMPLA EX FUTURO.

Ga sa, *sudabo,*	Sa he, *sudare aqua,*	Suda.
Gui ze, *visitabis,*	Za wa, *visitare hìc,*	Visita.
Da hie, *dimittet,*	Hie wi, *dimittere simul,*	Domitte.
Ga zê he, *ave dicemus,*	Zê gua, *ave dicere pes,**	Saluta.
Gui cā wi, *ædificabitis,*	Cā do, *ædificare petra,*	Ædifica.
Gui zā hū, *volabitis,*	Zā wi, *volare simul,*	Volato.
Ga yà yu, *erunt longè,*	Yà bu, *esse longè ibi,*	Longè esto.

Alia verba in imperativo repetuntur.

EXEMPLA EX FUTURO IMPERFECTO.

Guaxta ne, *voluero,*	Nèè, *velle velle,*	Volîto.
Guasca tè, *feceris,*	Tètè, *facere facere,*	Fac.
Guasa pe, *texerit,*	Pepe, *texere texere,*	Texe.
Guasta he hè, *tussiverimus,*	Hèhè, *tussire tussire,*	Tussi.
Guasca hu wi, *nominaveritis,*	Hu hu, *nominare nominare,*	Nomina.
Guasca tzū hū, *temueritis,*	Tzūtzū, *timere timere,*	Time.
Guasa tê yu, *tetigerunt,*	Têtê, *tangere tangere,*	Tange.

Alia verba composita ex duobus syllabis sunt, quæ cùm aliquid simile significent, ut idea composita exprimatur, duæ syllabæ unum verbum constituunt; ut *huehia,* respirare; *hue* enim exhalare, et *hia* halitum, et hæc licet videantur non monosyllabica, sunt quidem, ut jàm exposuimus.

* Othomiti Indi, cùm quemque salutant, pedem retrò movent, corpusque inclinatum habent.

ANTIQUA OTHOMITORUM CONJUGANDI FORMA, CUJUS ET VESTIGIA NUNC IN EORUM LINGUA MANET.

Præsens.	*Ni rza,* evenire (nunc temporis).
Præteritum.	*Ma* vel *mi rza,* evenisse (anteà).
Futurum.	*Na rza,* eventurum (in futuro).
Præsens.	*Ni ê,* senire (nunc temporis).
Præteritum.	*Ma* vel *mi ê,* senisse (anteà).
Futurum.	*Nā ê,* seniturus (in futuro).
Imperat.	*Eê,* senito. Plur. *Ewi,* vos senite.

Hoc imperativi artificium usque nunc conservatur.

QUODLIBET NOMEN ADJECTIVUM UT VERBUM CONJUGATUR : QUÆDAM HIC EXHIBENDA.

Di *vel* dna yē, *Ego sum humanus.*	Ye we, *Humanus esto.*
Na (ña) *vel* gui nhò, *Tu es bonus.*	Nhò we, *Bonus esto.*
Na *vel* y hāi, *Ille est terreus.*	Hāi we, *Terreus esto.*
Di *vel* dna otho he, *Nos sumus nihil.*	Otho we, *Esto nihil.*
Na (ña) *vel* gui meti wi, *Vos estis divites.*	Meti we, *Dives esto.*
Na (ña) *vel* gui dodo hū, *Vos estis stulti.*	Dodo we, *Stultus esto.*
Na *vel* y hui yū, *Illi sunt tres.*	Hiū we, *Triplex esto.*
Dna *vel* do ra mhā, *Ego eram unicus.*	Ra we, *Unus esto.*
Na (ña) *vel* gui nyē mhā, *Tu vacuus eras.*	Nyē we, *Vacuus esto.*
Na *vel* y na mhā, *Ille erat otiosus.*	Na we, *Otiosus esto.*
Da *vel* sta nē, *Ego fui strenuus.*	Nē we, *Strenuus esto.*
Ga *vel* sca hmū, *Tu fuisti virgo.*	Hmū we, *Virgo esto.*
Di *vel* sa hmū*, *Ille fuit dominus.*	Hmū we, *Dominus esto.*
Sta te hma, *Ego fueram aliquid.*	Te we, *Aliquid esto.*
Ga o, *Ego ero inimicus.*	O we, *Inimicus esto.*
Gasta enthò, *Ego fuero pulcherrimus.*	Enthò we, *Pulcherrimus esto.*

Ex suprà dictis, non modò verba in Othomitorum linguâ monosyllabica esse, sed et illos verbo substantivo carere omninò patet. Nam, quâ illi de causâ, quo nunquàm uterentur verbum habuissent ? Tarasci enim verbo *eni* (esse) et Mexicani verbo *ca*, quod idem significat, licet non frequentèr, tamen aliquandò, et primi illi verbis ex substantivo *eni* compositis, multotiès utuntur. Hoc mihi certum, Hispanos ex particulâ *we,* verbum illud, quod solùm in Hispanorum Othomitè loquentium sonat, totum confecisse. Non tamen Indi illud inventum receperunt, sed poterimus ne illam divinam sententiam Ego sum qui sum Othomitè reddere ? Possumus quidem, et ità, ni fallor : *ma hu nga,* "meum nomen ego." Lingua illa, suâ ex naturâ, illud non repugnat; sed intelligeretur vel ne ab Indis hæc sententia ? hoc nimirùm nescio, et nemo, nisi priùs experiatur, scire potest.

* Hmū, *dominus*, et hmū, *virgo*, sunt homonyma, sed variis modis distingui possunt, additione syllabarum significantium, ut apud sinenses, vel usu synonymorum, quorum multa sunt in hâc linguâ.

D.

ORATIO DOMINICA OTHOMITE VERSA CUM SCHOLIIS.

Ut meliùs hujus linguæ indoles cognoscatur, orationis Dominicæ versionem ab Andreâ Olmos scriptam, à Ramirezio* deindè, et à Joachimo Yepes postremò correctam adducere placuit; illamque, duobus aliis modis, quibus lingua ea facere posset, addam. Latina translatio llteralis omninò est.

1. Ma thà he ni bùy mahētsi	1. Noster pater habitas cœlum
2. Da ne ansū ni hūhū	2. Vocabunt sanctum tuum nomen,
3. Da ēhē ga he ni bùy	3. Veniet ergà nos tua habitatio,
4. Da kha ni hnee	4. Facient tua voluntas
5. Ngù wa na hày	5. Et ità hic terra
6. Te ngù mahētsi	6. Sicut cœlum
7. Ma hmē he ta nà pa	7. Noster panis quæque dies (cujusque diei)
8. Rà he na ra pa ya	8. Da nos unus dies nova (hodiè)
9. Ha puni he	9. Et parce nos
10. Ma dupatè he	10. Nostra debita
11. Tēngù di puni he	11. Sicut nos parcimus
12. U ma ndupatè he	12. Nunc debitores nostri
13. Ha yo wi hē he	13. Et cave ne permittere nos
14. Ga he kha na tzò cadi	14. Labemur in turpis actio
15. Ma na pehe he hin nhò.	15. Sed salva nos non bonum, (à non bono).
16. Da kha.	16. Facient, (hoc est *Amen*).

SCHOLIA.

1. Ma thà he ni bùy mahētsi.

Ma, meus; *thà*, pater; *he*, nos (meus pater nos, *i. e.* noster pater); *ni*, tu, tua; *bùy*, habitare, habitatio; *ma*, latus, latitudo; *hē*, extensus, extensio; *tsi*, in circùm, *i. e.* cœlum.

2. Da ne ansū ni hūhū.

Da, futuri indicativi tertiæ personæ particula; *ne*, vocare; *ansū*, ab Hispano *Santo; ni*, tu, tuum; *hū*, nominare, nomen, hìc bis repetitum cultûs gratiâ.

3. Da ēhē ga he ni bùy.

Da, futuri signum; *ē*, venire; *hē*, accedere; *ga*, ergà; *he*, nos; *ni bùy*, tua habitatio (regnum tuum, cœlum).

4. Da kha ni hnee.

Da, (ut suprà); *kha*, facere; *ni*, tua; *hnee*, voluntas, (facient tuam voluntatem).

5. Ngù wa na hày.

Ngù, tantò, ità; *wa*, hìc; *na*, illa, (pronomen articuli vices gerens); *hày*, terra, (ità hic *in* terrâ).

* Oraciones y Doctrina Cristiana en Othomi, aprobadas por el tercio Concilio Mexicano; Mexico 16—. Hìc in Bibliothecis hoc opus non invenitur.

6. Te ngù mahētsi.

Te, quod; *ngù,* tantò, ità; *mahētsi,* vide suprà, No. 1., (quod sonat, sicut *in* lato spatio, i. e. cœlo).

7. Ma hmē he ta nà pa.

Ma, meus; *hmē,* panis; *he,* nos; *ta* vel *da,* quæque; *nà, da,* quæque; *pa,* dies, tempus, epocha, (panem nostrum omnium dierum, omnium temporum, i. e. quotidianum).

8. Rà he na ra pa ya.

Rà vel *da,* dato; *he,* nos; *na,* particula, vide suprà, No. 5.; *ra,* una; *pa,* dies; *ya,* nova (da nobis in hâc die novâ, i. e. hodiè).

9. Ha puni he.

Ha, et; *pu,* dimittere; *ni,* germinare; *he,* nos. Hìc figurâ Othomiti utuntur; dimitte germinare; non permittas crescere; dele, extingue, (dimitte nobis).

10. Ma dupatè he.

Ma, meus; *du,* debere; *pa,* vendere; *tè,* facere; sic formatur *dupatè,* debere vendere facere, i. e. debita; *he,* nos, i. e. nostra.

Hæc sententia litteratim sonat : meus nòs debere vendere facere (debita nostra).

11. Tēngù di puni he.

Tē, quod; *ngù,* ità; *di,* præsentis indicativi primæ personæ signum ; *puni,* vide supra, 9; *he,* nos.—Hoc litteratim: quod (sicut) dimittere vel parcere nos (dimittimus).

12. U ma ndupatè he.

U, nunc; *ma,* meus; *ndupatè,* vide supra, 10.; *he,* nos. Litteratim : meus debitor venditor factor nos, i. e. debitoribus nostris. De modo loquendi " meus nos," vide supra, No. 1.

13. Ha yo wi hē he.

Ha, et; *yo,* non, ne; *wi,* tu, et secundæ personæ futuri particula; *hē,* consentire; *he,* nos, (et nos non permitte).

14. Ga he kha na tzò cadi.

Ga, labi; *he,* nos; *kha,* in, apud; *na,* articulus; *tzò,* turpis; *ca,* perficere; *di,* exequi. Hoc litteratim sonat : labi perficere exequi in turpe, i. e. turpè agere.

15. Ma na pehe he hin nhò.

Ma, sed; *na,* potiùs; *pe,* redimere, salvare; *he,* nos; *hin,* non; *nhò,* bonum. Sed salva nos à non bono, (libera nos à malo).

Posset etiam illa Oratio sic verti.

Go sna thà	*Domine meus pater*
To wi bùy	*Qui tu habitas*
Hē tsi	*Extensionem incircum* (*cœlum*)
Dama ka ni hū	*Dicent sanctum tuum nomen*
Dadi ni hne	*Exequatur tui voluntas*
Hài he hētsi	*Terrâ* (in) *et cœlo*
Ma hmē ta pa	*Meus panis quæque tempus*
Sa da he ni	*Placeat* (si) *da nos nunc*
Ha puni ma thày he	*Et parcere germinare mea debita nos*
Ngù i pu ma thày tì he	*Sicut parcimus meus debiti factor nos* (nostros)
Ha yo ho he ga zo tzò di	*Et cave ne consentire nos labi provocare exequi.*

Tertia versio, particulis expressis facta.

Ma thà hi* he	Meus pater venerabilis nos
We wibùy† kha hētsi	Qui moras apud cœlum
Kha ni hu	Divinum tuum nomen
Dadi ni hne	Exequatur tui (tua) voluntas
Bi kho na hày	Infrà in illâ terra
Ra ña kha hētsi	Æqualiter (ac) suprà in cœlo
Dada se‡ he ma hmē he	Da, concede ad nos (nobis) meus panis nos (panem nostrum)
Yo gazo sec§ tzòdi	Cave *ne* cademus (cadamus) propter tentationem.

E.

Omnia adjectiva, abstractaque nomina, verba et adverbia; omniaque verba et abstracta nomina, adjectiva, substantivaque esse possunt.

EXEMPLA.

1. Na nhò nhò ye i nhò he nhò.

Na nhò, bonitas; *nhò,* boni; *ye,* viri; *i,* verbalis particula; *nhò,* bona (est); *he* vel *ha,* et; *nhò,* benè.

Bonitas boni viri bona est et benè.

2.	Hiatzi	i hiatzi	hiatzi	hiatzi thò.					
	Lux	lucescit	lucens	lucidè.					
3.	Da sa	na tsò	tsò.						
	Arridebo	impietas	impius.						

Arridebo impietatem impii.

4.	Mādi	na bādi :	na bādi	mēhi.					
	Ama	sapientiam :	sapiens	felix (est).					
5.	Mādi	Okha :	na mādi	Okha :	na mādi	Okha	hi	he	bùy.
	Ama	Deum :	amator	Dei :	amor	Dei	felicitas	et	vita.

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* *Ta ki,* pater venerabilis; sed *ke, ki, i,* nihil adjuncto, ad æquales, cultûs gratiâ, applicatur; tamen Sandoval, et hoc in loco, eo usus est. Rectiùs *ma kha ta,* vel *ka ta,* vel *sam mi,* Divine Pater, Sancte Pater. Vide not. 1.

† Dissyllaba dividenda sunt, particulæ hic solùm adjunguntur ut verborum numerus in textû et versione æqualis sit. Idem est ordo verborum in ambobus.

‡ Particula *se,* utilitatem damnum habenti designans, personæ adhærere potest; undè æquivalens illa Hispano *para,* Anglo *to* vel *for,* Gallico *pour* vel *à,* et Sinensi particulæ *iu.* Ferè eâ nunquàm, nec aliâ Indi utuntur.

§ *Sec,* propter; utitur etiam pro *à* vel *ab* inter Latinos, ut *yeou* apud Sinas.

F.

"Le substantif, lorsqu'il est sujet d'un verbe quelconque, se place avant, et quand il est complément d'un verbe actif, après le verbe." Remusat, Sect. 83. Hoc etiàm in linguâ Othomiticâ accidit.

EXEMPLA.

1. Do	snu	he	ña	cà	di
Petra	caput	et	absconditum	sapere	exequi

Hoc est: Caput petreum (stultus, vel dativè, stulto) et absconditum, i. e. illi absconditum est, nequit; sapere exequi, i. e. sapere; *di,* facere vel exequi, particula verbalis est. Stultus non est sapiens.

2. To	i ma	ya* tza	ya Okha	do snu
Qui	culpat	consilia	Deorum	stultus (est)

Qui Deorum consilia culpet, stultus, inscitusque est.—*Plaut.* in *Mil. Glor.* Act. III. Sc. 1.

3. Na tzu	i so	ya du	kir	mùy.
Timor	arguit	degeneres	viles	animos, (*mùy,* cor).

Degeneres animos timor arguit.—Virg. Æn. 1. 6.

G.

VARIÆ PRÆPOSITIONES.

Ga, ex; *bi,* sub; *se,* ad; *wi,* simul; *se,* suprà; *kha,* in, apud; aliaque hujusmodi.

Ngu ga do, Domus ex petrâ.
Ngu bi ngu, Domus sub domo.
Ngu se he, Domus ad nos (nobis).
Nga he ni wi, Ego et tu simul.
Ngu se ngu, Domus suprà domum.
Kha ngu, Apud domum, in domo.

H.

Nec solùm inter Anahuacenses nationes, Othomiti fuêre, qui triplex pro primâ personâ pronomen habuerint, habent et Mexicani; en illorum lingua cum Othomiticâ comparata. Sic *Ego* exprimitur:

Mexic.	Nehuatl,	nehua,	ne.
Othom.	nga,	nga-nga,	ngwi.

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* *Ya* vel *ye,* signum pluralis.

I.

FORMÆ AD CULTUM VEL REVERENTIAM PERTINENTES.

Apud æquales dicitur :

Ni	ho	wi mā	*vel*	i mā	na bùy.
Tua	dignatio	amas		amat	vitam.

Ni	ki	i bùy	wa	i. e. Tu vivis.
Tua	veneratio	vivit	hìc	

Ad superiores senesque, sic Othomiti loquuntur :

Rzu	ki	i ā	i e. Tu dormis.
Altitudo	venerabilis	dormit	

Ad nobilem feminam, et etiam ad æqualis qualitatis mulieres :

Ti nsu	mā	i. e. Tu dic.
Divitiæ femininæ	dicito	

Ad inferiores verò :

Tsi nsu	mā	i. e. Tu dic.
Surculus femineus	dicito	

Tsi *vel* Tu	mā	i. e. Fili mi, dic.
filius	dicito	

K.

NONNULLA ADVERBIA.

Bùy, ità; *nkha,* sicut; *nkha bùy,* ità; *nu,* iste, hìc; *wa,* hìc; *nuwa,* hìc; *ni,* illùc; *nuni,* illùc.

L.

COMPARATIO NUMERALIUM IN LINGUA SINICA ET VARIIS LINGUIS ANAHUACENSIBUS.

	Sinicè.	Othomiticè.	Mexicanè.	Huastecè.
1.	I	na, ra	ce	hun
2.	Eúl	yo, ho	ome	tzab
3.	Sân	hiū	yey	ox
4.	Ssé	gò	naui	tze
5.	Où	kū-tto	macuilli	bò
6.	Lou	ratò (unus et quinque)	chiquace	acac
7.	Thsi	yotò (duo et quinque)	chicome	buc
8.	Pa	hiātò (tres et quinque)	chicuey	huaxic
9.	Kieoù	gotò (quatuor et quinque)	chicunaui	belleuh
10.	Chi	rēta	mactlactli	lahu.

M.

'ΑΝΑΚΡΕΟΝΤΟΣ—Ωδὴ ΙΑ'.

Εἰς σεαυτὸν.

Λεγουσιν αἱ γυναῖκες
"'Ανακρέων, γέρων εἶ·
"Λαβων ἔσοπτρον, αθρει
"Κόμας μὲν οὐκ ἔτ οὖσας
"Ψιλὸν δὲ σευ μέτρωπον."
Εγω δὲ τας κόμας μὲν,
Εἴτ' εἰσὶν, εἴτ' απῆλθον,
Οὐκ οἶδα τουτο δ'οἶδα,
Ως τω γέροντι μαλλον
Πρέπει τα τερπνα παίζειν,
Οσῳ πέλας τα Μοίρης.

BARNESII LATINA VERSIO.

ANACREONTIS.—Ode xi.

De se ipso.

Dicunt *mihi* fœminæ,
"O Anacreon, senex es:
"Accepto speculo, contemplare
"Comas quidem non ampliùs existentes,
"Glabramque tuam frontem."
Ego sanè, quod ad comas attinet
Utrùm sint, an abierint,
Haud novi, hoc autem novi,
Quod seni *tantò* magis
Convenit jucundè ludere,
Quantò propior *ei* mors sit.

VERSIO OTHOMITICA.

Na dusu rēta n–ra.

NA NACREO.

Ga bicē.

1. Ye nsu tsi di mā-i
2. Go Nacreò, a ndè:
3. Sa kuti na hiē nuti
4. Y khso na stà
5. Ha ña ni dē
6. Khuani di him phò
7. Maz ye stà sa kha
8. Gua nùy spi mā
9. Haa i pa nùa
10. Yho gu manra na dà skhoo
11. Da bùy ha da khò hia
12. Ngu, da cu na du.

Scholia.

Na dusu rēta n-ra na Nacreò: Anacreontis Ode undecima.

Na, pronomen *ille, a, ud*, articuli vices gerens; *dusu*, canere *vel* cantus; *rēta* decem, decimus; *n-ra*, unus; *na Nacreò*, ille Anacreon, sensu genitivo audiendus, ut in veteri linguâ Gallicâ usus fuit, et adhùc *l'Hotel-Dieu* pro *l'Hotel* de *Dieu*, dicitur. Ille cantus undecimus Anacreontis.

Ga bi cē: De se ipso.

Ga, præpositio, quasi *ex* apud Latinos; *bi*, accusativum et dativum *nana* pronominis personalis; *cē*, pronomini unitum, demonstrativum facit.

ODE.—*Linea prima.*

Ye nsu tsi di mā-i: Juvenes fœminæ dicunt mihi.

Ye, signum pluralis, *pluviam** significat; *nsu*, genus fœmininum designat; *tsi*, sur-

* Character Sinensium *tù*, pluviam significans, qui inter radicales 173 numeratur, quatuor aquæ gutta-

culus, metaphoricè, aliquid tenerum; *ye nu tsi*, juvenes fœminæ; *di*, particula verbum designans; *mā*, dicere; *i*, signum pluralis, *ye* repetitum et abbreviatum.

Pluvia (multitudo) surculorum tenellorum (juvenes fœminæ) dicere illæ, (id est, dicunt): *mihi* subauditur.

Linea secunda.

Go Nacreò, a ndè: Domine Anacreon, senex es.

Go, particula reverentialis, quæ nominibus propriis affigitur; *Nacreò*, Anacreon, quod sonat *Domine Anacreon; a* ex *gua* abbreviatum, est pronomen personale secundæ personæ, *tu; ndè*, senex; (*es* subauditur, quia hæc lingua verbo substantivo caret).

Domine Anacreon, tu (*es*) senex.

Linea tertia.

Sa kutti na hiē nuti. Sa, verbum reverentiale, si vis, placeat tibi; *kutti, kut*, sumere, accipere; *ti*, facere, exequi; *na*, articulus; *hiē*, speculum; *nuti*, contemplare facere, forma imperativi.

Placeat tibi, vel si tibi placeat, accipe speculum, et contempla.

Linea quarta.

Y khoo na stā. Na stā, capillus, capillamentum; *khoo*, abesse; *y*, particula præfixa, signum tertiæ personæ singularis præsentis indicativi.

Abest ille capillus, vel illud capillamentum.

Linea quinta.

Ha ña ni dē. Ha, et; *dē*, frons; *ni*, tua; *ña*, nuda.

Et nuda frons tua (*est*).

Linea sexta.

Khuani di him phò. Khuani, verum, verè, à *kha*, veritas, realitas, quod existit; *di*, particula verbis præfixa, primam personam præsentis modi indicativi, in numero singulari indicans; *him*, particula negativa, non; *phò*, scire; *di phò*, scio; *di him phò*, nescio.

Verè, ego nescio.

Linea septima.

Maz ye stà sa kha. Maz, utrum; *ye stà*, capilli, (*ye*, pluvia, signum pluralis); *kha*, adesse, opponitur *kha* vel *khou*, abesse; vide lineam 4. *Sa*, particula præfixa, præteritum indicans.

Utrùm capilli adfuêre.

Linea octava.

Gua nù-i spi ma. Gua, adverbium, *aut, vel; nù-i*, pronomen demonstrativum et relativum, *ille, a, ud; i*, affixum, signum pluralis, à *ye*, vide lin. 1.; *ma*, volare, fugire; *spi*, verbalis particula, tertiam personam præteriti indicans.

Aut *si* illi volarunt vel fugerunt.

Linea nona.

Ha-a i pa nùa. Haa, particula affirmativa, *si* Hispanicum, et *yes* Anglicum, hìc verò pro *sed*, vel *autem* utitur; *i pa* vel *di pa* vel *di phò*, scio, vide lin. 6.; *nùa*, hoc, illud, quod; (vide lin. 8).

Hoc autem novi.

rum imaginem continet; quatuor etiàm guttas, sed diversè positas, habet character *chú*, omnes, signum pluralis. Quæ hìc similitudo idearum Sinenses inter et Othomitos!

Linea decima.

Y ho gu ma nra na dà skoo.. *Y ho,* decet; *ho,* convenire, *y* signum personæ, vide lin. 4.; *gu,* contractio ab *angu,* tantum, tantò; *nra,* contractio à *manra,* magis; *na,* articulus indefinitus, unus, a, um, Anglicè *a, an ; dà skhoo,* à *dà,* florens, floridus, et *khoo,* abesse, absens, (vide lin. 4.), homo qui florescere desinit, senex.

Florem absentem (senem) tantò magis decet.

Linea undecima.

Da bùy ha kho hia. *Da bùy,* (*u* nasale) *bùy,* vivere; *da,* particula præfixa, tertiam personam futuri temporis indicans, quod hìc infinitivi vices gerit, et sic dicitur *ut vivet,* pro *ut vivat,* hæc lingua etiam modo subjunctivo carens. *Ha,* (conj.) et, vide lin. 5, 9; *khohia,* esse vel stare in luce, metaphoricè, jucundè vivere; *da,* signum futuri, ut suprà dictum.

In luce stare (jucundè vivere).

Linea duodecima.

Ngu da cu na du. *Ngu,* contractio ab *hangu,* minus, quod hìc pro *magis* utitur. In hâc lingua, *magis* nunquam sibi opponitur. Tantò magis illum amas, tantò *minus* (magis) te odit. *Minus* hìc distantiam denotat, et tantò minùs ejus odium distat à tuo amore, hæc sententia significat. Ergò in hoc versu, tantò minùs mors à te distat, Othomitus dicere vult, quamvis verbum *appropinquare* mox sequatur. *Na du : du,* nomen substantivum, mors; *na,* articulus præfixus, ut suprà sæpè dictum. *Da cu : cu,* contractio à *cuattu,* appropinquare; *da,* signum futuri, vide lin. 11.

Quantò hìc subauditur, ut *tantò* in Græco.

Minùs (quantò magis) mors appropinquat, i. e. *quantò* minùs mors *ab illo* distet : quantò à minori distantiâ mors illi appropinquet.

ERRATA.

P. 252, *l.* 7 *à capite,* alium *lege* aliam.
P. 255, *l.* 17 *à capite, dele* 10.
P. 256, *l.* 8 *à calce,* eadem *lege* eâdem.
P. 263, *l.* 11 *à capite,* Hebræi *lege* Hebræâ.
P. 263, *l.* 11 *à capite,* Græci *lege* Græcâ.
P. 264, *l.* 14 *à calce,* quos *lege* qui.
P. 266, *l.* 13 *à calce,* albâ *lege* albo.

ARTICLE XIII.

Practical Rule for Calculating, from the Elements in the Nautical Almanac, the Circumstances of an Eclipse of the Sun, for a Particular Place. By John Gummere, Teacher of Natural Philosophy and Mathematics in the Friends' School at Haverford, Pennsylvania. Read March 6th, 1835.

THE following rule, deduced from a known formula, gives, with little labour, the different circumstances of an eclipse of the sun, very nearly; the greatest error in time seldom exceeding half a minute. It also furnishes certain data that facilitate the exact calculation, when this is required. The multiplication of quantities by the sine, or cosine of an arc or angle, is performed by a Traverse Table, as in Henderson's method of Predicting Occultations, given in the fourth volume of the Memoirs of the Astronomical Society of London. The rule is adapted to the use of the traverse tables usually contained in treatises on Surveying. In these tables, the difference of latitude and the departure are given for every quarter of a degree, of course, from 0° to 90°; and but little error results, if the required quantity is taken in the column corresponding to the course which is nearest to the given angle, without correction for the difference between the two. It is, however, easy to estimate and apply the proportional part, corresponding to this difference; and it is better to do so. When the given angle exceeds 90°, it must be subtracted from 180°, and the remainder taken as the course.

In calculating the parallaxes, the products of ten times the distance of the given place from the earth's centre, by the cosine and sine of its reduced latitude, are used. These products being constant for a given place, serve, when once obtained, for all calculations of eclipses of the sun, or of occultations for that place. Let them be denoted, respectively, by X and Y. Then, to obtain them, add respectively, to the logarithmic cosine and sine of the latitude of the place, the logarithms x and y, taken from Table I. of the annexed tables, with the latitude of the place as the argument, and reject 10 from the index of each sum. The results will be the logarithms of X and Y. These logarithms are used in the exact calculation of the parallaxes. The natural numbers corresponding to them, taken out to two decimal places, are the values of X and Y, that are used in the approximate calculation. These values are given in Table II. for each degree of latitude.

In the addition and subtraction of quantities, except those which are in time, the algebraic rules for performing these operations are to be observed. Wherever the rule directs the root of a quantity to be taken, it is the positive square root that is implied.

The quantities, denominated in the rule, parallaxes in right ascension and declination, are not strictly those quantities; they, however, differ but little from them, and are the quantities required in this method of calculation.

RULE.

1. Consider north declinations and north horary motions as +, and south ones as —. Find the difference of the sun's and moon's declinations, by subtracting the declination of the sun, as given in the elements, from that of the moon. In like manner find the difference of the horary motions of the sun and moon, in right ascension, the difference of their horary motions in declination, and the difference of their equatorial horizontal parallaxes.

2. Multiply the difference of the sun's and moon's declinations, re-

duced to seconds, by 10, and divide the product by the difference of the parallaxes, also reduced to seconds, extending the quotient to two decimal places, and denote it by q. Do the same with the difference of the horary motions in right ascension, denoting the quotient by P'; with the difference of the horary motions in declination, denoting the quotient by q'; and with the sun's semidiameter, denoting the quotient by r. With the moon's declination, as a course, and P' as a distance, enter the traverse table, and taking the corresponding difference of latitude, mark it $+$, and denote it by p'. Then will q, p', q' and r, respectively express the difference of the declinations, the difference of the horary motions in right ascension, the difference of the horary motions in declination, and the sun's semidiameter, in such parts as the difference of the parallaxes contains 10; the difference of the horary motions in right ascension being reduced to the parallel of declination passing through the moon's centre. Let p denote the difference of the sun's and moon's right ascensions, expressed in similar parts, and reduced to the same parallel. At the time of conjunction in right ascension $p = 0$.

3. Denote the Greenwich mean time of conjunction in right ascension by T. Find from the Nautical Almanac the corresponding equation of time, and apply it to T, so as to obtain the apparent time. To the apparent time apply the longitude of the given place from Greenwich, in time, by adding when the longitude is east, but subtracting when it is west, and convert the sum or remainder into degrees. If the result is less than 180°, it will be the hour angle at the time T, and will be $+$. If it exceeds 180°, subtract it from 360°, and the remainder will be the hour angle, and will be $-$. Denote the hour angle by H.

With the sun's declination as a course, and the value of Y for the given place as a distance, enter the traverse table, and take the corresponding difference of latitude, marking it $+$ when the latitude of the place is north, but $-$ when it is south, and denote it by b. Take also the departure, marking it with the same sign as the declination when the latitude is north, but with a contrary sign when it is south, and denote it by f.

4. The values of p', q', r, b, and f, may be regarded as constant

during the continuance of the eclipse. But the value $p = 0$, and the values of q and H, found as above, appertain only to the time T. To find them for another time T′, proceed thus. As 60 minutes : diff. of T and T′ : : p' : p. If T′ is later than T, the value of p is +, but if earlier, it is —. Again, as 60 minutes : diff. of T and T′ : : q' : a quantity with the same sign as q', which, added to the value of q, at the time T, when T′ is later than T, but subtracted from it when T′ is earlier, will give the required value of q. Also, as 60 minutes : diff. of T and T′ : : 15° : a quantity, which added to the value of H, at the time T, when T′ is later than T, but subtracted when it is earlier, will give the required value of H.

5. With the value of H, at the time T, as a course, and the value of X, for the given place, as a distance, enter the traverse table, and take the corresponding departure, marking it with the same sign as H, and denoting it by u. Take also the difference of latitude, marking it +, when H is less than 90°, but —, when H exceeds 90°, and denote it by C. With the sun's declination as a course, and C as a distance, find the departure, marking with the same sign as C when the declination is +, but with a contrary sign when it is —, and denote it by c. Subtract c from b, and denote the result by v. Then will u and v be the parallaxes in right ascension and declination, at the time T.

Using Table IV., add together the squares of $(p - u)$ and $(q - v)$, denoting the root of the sum, which need not however be taken out, by M. Then will M denote the apparent distance of the centres of the sun and moon, at the time T.

6. Take a time T′, an hour earlier or later than T, according as the value of $(p - u)$ at the time T, is + or —, and find for this time, by the preceding articles, the values of p, q, H, u, C, c, and v; and thence the square of the apparent distance of the centres, denoting the root by M′.

Subtract, respectively, the values of $(p - u)$ and $(q - v)$ at the earlier of the times T and T′, from their values at the later time, and denote the results by $(p' - u')$ and $(q' - v')$. Add together the squares of $(p' - u')$ and $(q' - v')$, and taking from the table the corresponding root, denote it by n. Then will n express the horary motion of the moon from the sun on the apparent relative orbit. To the square of n add the square of M, and from the sum subtract the square of M′, denoting the remainder by N^2. Multiply N^2 by 30, and divide the product by the square of n, extending the quotient to one decimal figure. This quotient will be an interval in minutes of time, which, being added to the time T, or subtracted from it, according as T′ is later or earlier than T, will give the time of greatest obscuration.

7. Taking now T′, to represent the time of greatest obscuration, find for this time the values of p, q, H, u, C, c, and v. Also, when taking c from the traverse table, take the corresponding difference of latitude, and marking it with the same sign as C, denote it by g. With $(f + g)$ as the argument, take from Table IX., to two figures, the correction of r. Subtract this correction from r, and denote the remainder by r'. To r' add 2.73, the moon's reduced semidiameter, and denote the sum by k. Now adding together the squares of $(p - u)$ and $(q - v)$, take the root of the sum, and denote it by m. Then will m express the least distance of the centres. Multiply $(k - m)$ by 6, and divide the product by r'. The quotient will express the *digits eclipsed;* on the northern limb if $(q - v)$ is +, but on the southern if it is —. If m is equal to, or greater than k, the eclipse will not be visible at the given place.

From the square of k subtract the square of m, and taking the root of the remainder, denote it by h. Then, as $n : h :: 60$ minutes : an interval of time, which being subtracted from the time of greatest obscuration, and added to it, will give approximate times of the beginning and end of the eclipse.

8. Taking T′ equal the approximate time of beginning, find as before, for this time, the values of p, q, H, u, C, c, g, v, r', and k. Also with the sun's declination as a course, and u as a distance, find the corresponding departure, marking it with the same sign as u, when the declination is +, but with a contrary sign when the declination is —, and denote it by E. Then with C and E, respectively as arguments, take the corresponding quantities from Table III., marking each with the same sign as its argument, and denote them by u' and v'. Then will u' and v' express the horary changes of the parallaxes in right ascension and declination, at the time T′.

From the square of k, subtract the square of m, and taking the root, denote it by h. Add together the squares of $(p - u)$ and $(q - v)$, and from the sum subtract the square of m. Take the root of the remainder, and denote it by h'. Add together the squares of $(p' - u')$ and $(q' - v')$, and taking the root of the sum, it will be the value of n, at the time T'. Then as n : diff. of h and h' :: 60 minutes : a correction, in minutes, which being added to T', or subtracted from it, according as h' is greater or less than h, will give the *corrected time of beginning*.

9. The corrected time of end is found in exactly the same manner, except that the correction is to be subtracted from T', the approximate time of end, when h' is greater than h, but added to it when h' is less than h.

10. From the values of $(p - u)$, $(q - v)$, u and v, at the approximate time of beginning, find, by means of their horary changes $(p' - u')$, $(q' - v')$, u' and v', their values at the corrected time of beginning. Then taking the values of $(p - u)$ and $(q - v)$, divide the less by the greater, extending the quotient to three decimal places, and marking it + when the signs of $(p - u)$ and $(q - v)$ are alike, but — when they are different. Then with the quotient as the argument, take the corresponding arc from the proper column of Table V., as denoted by the remarks at the head of the table. If $(p - u)$ is +, denote this arc by P, but if it is —, add 180° to the arc, and denote the sum by P. With the values of u and v, proceed in the same manner to find another arc, denoting it by Q, if u is +, but adding 180° to it if u is —, and denoting the sum by Q. Subtract P from Q, increasing the latter by 360° when it is less than the former, and denote the remainder by V. Then will V express the distance from the sun's vertex to the point of the disc at which the eclipse commences, measured on the circumference of the disc, from the vertex to the right hand.

11. The times of beginning, greatest obscuration, and end, found as above, are expressed in Greenwich mean time, and may be changed to mean time of the given place, by adding or subtracting the difference of meridians in time, according as the place is east or west from Greenwich.

Note 1. The calculation will be facilitated by having two small tables, containing the values of u and C, for each degree of the hour angle, and b and f for each degree of declination, calculated for the place, from the expressions $u = \text{X sin. H}$, $\text{C} = \text{X cos. H}$, $b = \text{Y cos. Decl.}$, and $f = \text{Y sin. Decl.}$ These tables will also be equally convenient in the calculation of occultations. Tables VI. and VII. contain those values, calculated for the latitude of Philadelphia.

2. If only a near approximation to the circumstances of the eclipse is required, the value of r may be used instead of r', and the values of h and n at the time of greatest obscuration may be taken, in finding the corrected times of beginning and end. Also in finding the point of the sun's disc at which the eclipse commences, the values of $(p - u)$, $(q - v)$, u and v, at the approximate time of beginning, may be used without correction; consequently, in this case f, g and E need not be found. The error thus produced in the time of beginning or end will seldom exceed a minute; and the error in the magnitude of the eclipse cannot amount to a tenth of a digit.

As an example, let it be required to calculate for Philadelphia, lat. 39° 57′ N. long., 5 h. 0 m. 44 sec. W., the circumstances of the eclipse of November 30th, 1834.

For Philadelphia $\text{X} = 7{\cdot}68$ and $\text{Y} = 6{\cdot}39$.

In the following calculation, the values of b, f, u and C are taken from Tables VI. and VII.; the same values will, however, be easily obtained from the traverse table, with perhaps occasionally a difference of a unit in the last decimal figure.

From the elements in the Nautical Almanac we obtain:

Greenwich mean time of conjunc. in R. A.,	Nov. 30d. 6h. 32·9m.		
Moon's declination, ...	— 20° 48′ 13″		
Sun's declination, ...	— 21 41 05		
Sun's semidiameter, ...	16 15		
Diff. of sun's and moon's declinations,	= + 52′ 52″	=	+ 3172″
Diff. of their hor. motions in R. A.,	= + 35 40	=	+ 2140
Diff. of their hor. motions in declin.,	= — 8 48	=	— 528
Diff. of their eq. horizontal parallaxes,	= 60 14	=	3614

$$p = 0,\ q = +\frac{3172 \times 10}{3614} = +\ 8{\cdot}78,\ P' = +\frac{2140 \times 10}{3614} = +\ 5{\cdot}92\ ;$$

$$p' = +\ 5{\cdot}54,\ q' = -\frac{528 \times 10}{3614} = -\ 1{\cdot}46,\ r = \frac{975 \times 10}{3614} = 2{\cdot}70.$$

		h. m.	
T. . = . . .		6 32·9	
Eq. of time, . .	+	11·1	$b = +\ 5{\cdot}93$
		6 44·0	
Long. W. . .	—	5 0·7	$f = -\ 2{\cdot}36$
		1 43·3	
H. . . .	+	25°.8	

$u = +\ 3{\cdot}34$, $C = +\ 6{\cdot}91$, $c = -\ 2{\cdot}55$, $v = +\ 8{\cdot}48$.

$p - u = -\ 3{\cdot}34$ sq. 11·16
$q - v = +\ 0{\cdot}30$ sq. 0·09

M. . . . sq. 11·25

h. m.
$T' = 7\ \ 32{\cdot}9$

$p = +\ 5{\cdot}54$, $q = +\ 7{\cdot}32$, $H = +\ 40°{\cdot}8$
$u = +\ 5{\cdot}02$, $C = +\ 5{\cdot}81$, $c = -\ 2{\cdot}15$, $v = +\ 8{\cdot}08$

$p - u = +\ 0{\cdot}52$	sq. 0.27	$p' - u' = +\ 3{\cdot}86$	sq. 14·90
$q - v = -\ 0{\cdot}76$	sq. 0·58	$q' - v' = +\ 1{\cdot}06$	sq. 1·12
M' . . .	sq. 0.85	$n = 4{\cdot}00$.	sq. 16·02
		M . . .	sq. 11·25
			27·27
		M' . . .	sq. 0·85
		N . . .	sq. 26·42

$$\frac{30\ N^2}{n^2} = \frac{26{\cdot}42 \times 30}{16{\cdot}02} = 49{\cdot}5 \text{ m.}$$

h. m. m. h. m.
6 32·9 + 49·5 = 7 22·4 = time of greatest obscuration.

h. m.
$T' = 7\ \ 22{\cdot}4$

$p = +\ 4{\cdot}57$, $q = 7{\cdot}58$, $H = +\ 38°{\cdot}2$
$u = +\ 4{\cdot}75$, $C = +\ 6{\cdot}03$, $c = -\ 2{\cdot}23$, $g = +\ 5{\cdot}54$, $v = +\ 8{\cdot}16$
$f + g = +\ 3{\cdot}18$, $r' = 2{\cdot}69$, $k = 5{\cdot}42$

$p - u = -\ 0{\cdot}18$ sq. 0·03
$q - v = -\ 0{\cdot}58$ sq. 0·34

$m = 0{\cdot}61$ sq. 0·37

$$\frac{6\ (k - m)}{r'} = \frac{4{\cdot}81 \times 6}{2{\cdot}69} = 10{\cdot}7$$ = digits eclipsed on southern limb.

$k = +\ 5{\cdot}42$ sq. 29·38
m . . sq. 0·37

$h =$ 5·39 sq. 29·01

m. h. m.
4·00 : 5·39 :: 60 : 1 20·8

h. m. h. m. h. m.
7 22·4 — 1 20·8 = 6 1·6 = approx. time of beginning,
7 22·4 + 1 20·8 = 8 43·2 = approx. time of end.

h. m.
T′ = 6 1·6

$p = -2{\cdot}89$, $q = +9{\cdot}54$, H = 18°·0, $u = +2{\cdot}37$, C = + 7·30
$c = -2{\cdot}70$, $g = +6{\cdot}78$, $v = +8{\cdot}63$, $f + g =$ 4·42, $r' =$ 2·68
$k =$ 5·41, E = — 0·88, $u' = +1{\cdot}91$, $v' = -0{\cdot}24$,

$k =$ 5·41, sq. 29·27 | $p - u = -5{\cdot}26$ sq. 27·67
m . . sq. 0·37 | $q - v = +0{\cdot}91$ sq. 0·83

$h =$ 5·38 sq. 28·90 | 28·50
$h' =$ 5·30 | m . . . . . sq. 0·37

Diff. = 0·08 | h' . = 5·30 sq. 28·13

$p' - u' = +3{\cdot}63$ sq. 13·18
$q' - v' = -1{\cdot}22$ sq. 1·49

n . = 3·83 sq. 14·67

m. m.
3·83 : 0·08 :: 60 : 1·3

h. m. m. h. m.
6 1·6 — 1·3 = 6 0·3 = corrected time of beginning.

h. m.
T′ = 8 43·2

$p = +12{\cdot}03$, $q = +5{\cdot}61$, H = 58°·4, $u = +6{\cdot}54$, C = + 4·02
$c = -1{\cdot}49$, $g = +3{\cdot}74$, $v = +7{\cdot}42$, $f + g = 1{\cdot}38$, $v' =$ 2·69
$k =$ 5·42, E = — 2·42, $u' = +1{\cdot}05$, $v' = -0{\cdot}63$,

$k =$ 5·42, sq. 29·38, | $p - u = +5{\cdot}49$, sq. 30·14
m . . sq. 0.37, | $q - v = -1{\cdot}81$, sq. 3·28

$h =$ 5·39, sq. 29·01, | 33·42
m . . . sq. 0·37

$p' - u' = +$ 4·49, sq. 20·16, | $h' =$. 5·75, sq. 33·05
$q' - v' = -$ 0·83, sq. 0·69, | $h =$. 5·39,

$n =$ 4·57, sq. 20·85, | Diff. = . 0·36.

m. m.
4·57 : 0·36 :: 60 : 4·7

h. m. m. h. m.
8 43·2 — 4·7 = 8 38·5 = corrected time of end.

h. m.
At. 6 0·3

$p - u = -5{\cdot}34,\quad q - v = +0{\cdot}94,\quad u = +2{\cdot}33,\quad v = +8{\cdot}64$

$$\frac{q-v}{p-u} = \frac{+0{\cdot}94}{-5{\cdot}34} = -{\cdot}176 \qquad P = 280^\circ{\cdot}0$$

$$\frac{u}{v} = \frac{+2{\cdot}33}{+8{\cdot}64} = +{\cdot}269 \qquad Q = 15^\circ{\cdot}1$$

$$V = Q - P = 95^\circ{\cdot}1$$

Changing the Greenwich mean times into Philadelphia mean times, we have,

	h.	m.
Beginning,	0	59·6
Greatest obscuration,	2	21·7
End,	3	37·8

The first part of the calculation, by note 2d to the rule, is the same as the preceding, except that f need not be found. The subsequent part, after the time of greatest obscuration is obtained, is as follows:—

h. m.
T′= 7 22·4

$p = +4{\cdot}57,\quad q = +7{\cdot}58,\quad H = +38^\circ{\cdot}2$

$u = +4{\cdot}75,\quad C = +6{\cdot}03,\quad c = -2{\cdot}23,\quad v = +8{\cdot}16$

$p - u = -0{\cdot}18 \qquad$ sq. 0·03

$q - v = -0{\cdot}58 \qquad$ sq. 0·34

$m = 0.61 \qquad$ sq. 0.37

$$\frac{6\,(k-m)}{r} = \frac{4{\cdot}82 + 6}{2{\cdot}70} = 10{\cdot}7 = \text{digits eclipsed.}$$

$k = 5{\cdot}43 \qquad$ sq. 29·48

$m \qquad$ sq. 0·37

$h = 5{\cdot}40 \qquad$ sq. 29·11

m. h. m.
4·00 : 5·40 : : 60 : 1 21·0

h. m. h. m. h. m.
7 22·4 — 1 21·0 = 6 1·4 = approx. time of begin.
7 22·4 + 1 21·0 = 8 43·4 = approx. time of end.

h. m.
T′ = 6 1·4

$p = -2{\cdot}91,\quad q = +9{\cdot}55,\quad H = 17^\circ{\cdot}9$

$u = +2{\cdot}36,\quad C = +7{\cdot}30,\quad c = -2{\cdot}70,\quad v = +8{\cdot}63$

$p - u = -5{\cdot}27$ sq. 27·77
$q - v = +0{\cdot}92$ sq. 0·85

28·62
m sq. 0·37

$h' = 5{\cdot}31$ sq. 28·25
$h = 5{\cdot}40$

Diff. $= 0{\cdot}09$

m. m.
4·00 : 0·09 : : 60 : 1·3

h. m. m. h. m.
6 1·4 — 1·3 = 6 0·1 = near approx. time of begin.

h. m.
T′ = 8 43·4
$p = +12{\cdot}05,\ q = +5{\cdot}60,\ H = 58°{\cdot}4$
$u = +6{\cdot}54,\ C = +4{\cdot}02,\ c = -1{\cdot}49,\ v = +7{\cdot}42$
$p - u = +5{\cdot}51$ sq. 30·36
$q - v = -1{\cdot}82$ sq. 3·31

33·67
m sq. 0·37

$h' = 5{\cdot}77$ sq. 33·30
$h = 5{\cdot}40$

Diff. $= 0{\cdot}37$

m. m.
4·00 : 0·37 : : 60 : 5·5

h. m. m. h. m.
8 43·4 — 5·5 = 8 37·9 = near approx. time of end.

h. m.
At 6 1·4

$$\frac{q - v}{p - u} = \frac{+0{\cdot}92}{-5{\cdot}27} = -{\cdot}174,\quad P = 279°{\cdot}8$$

$$\frac{u}{v} = +\frac{2{\cdot}36}{8{\cdot}63} = +{\cdot}273,\quad Q = 15°{\cdot}2$$

$$V = Q - P = 95°{\cdot}4$$

If it is required to find the times of beginning and end with greater precision than by the foregoing rule, let T′ represent the corrected Greenwich mean time of beginning, taken to the nearest minute, and find from the Nautical Almanac the corresponding sidereal time, expressing it in arc. To the sidereal time thus expressed apply the longitude of the place, also in arc, by adding, if the longitude is east, but subtracting if it is west, and denote the result by Z. Find also, for the time T′, the sun's right ascension in arc, denoting it by A; the sun's declination, denoting it by D; the moon's right ascension, in arc, denoting it by a; the moon's declination, denoting it by d; and the moon's equatorial horizontal parallax. Take the difference of the sun's and moon's parallaxes, and denote it by G. Also denote the sun's semidiameter by R. Then find the values of p, q, r, u, and v, to four decimal places, by the following formulas.

$$p = \frac{10 \sin. (a - A) \cos. d}{\sin. G}$$

$$q = \frac{10 \sin. (d - D)}{\sin. G} + \tfrac{1}{2} p \sin. D \sin. (a - A)$$

$$r = \frac{10 \text{ tang. } R \cos. (d - D) \cos. (a - A)}{\sin. G}$$

$$u = X \sin (Z - A)$$

$$v = Y \cos. D - X \sin. D \cos. (Z - A)$$

Find the value of g, for the time T, as directed in the preceding rule, and with the argument $(f + g)$ take the correction of r from Table IX., and subtracting it from r, obtain r'. Take the moon's semidiameter from Table VIII., with the equatorial parallax as the argument, and adding it to r', the sum will be the value of k. The square of m, and the value of n, at the approximate time of beginning, found in the preceding calculation, although extending only to two decimal places, will be sufficiently accurate for the present calculation.

Using a common table of squares, and proportioning for the last two figures of the roots, find the values of h and h', as directed in article 8 of the foregoing rule, and thence a second correction; which being applied to T′, as there directed, will give the true time of beginning.

A similar calculation for the corrected time of end, will give the true time of end.

The corrected time of beginning of the eclipse just calculated, has been found to be 6 h. 0·3 m. Take therefore T′ = 6 h. 0 m. The sidereal time corresponding to this time is 339° 7′ 22″.2, expressed in arc. Hence for Philadelphia, long. 75° 10′ 59″ W., we have, Z = 263° 56′ 23″.2, at the time T′. We also find A = 246° 21′ 7″.8, D =

— 21° 40′ 51″.5, a = 246° 1′ 33″.1, d = — 20° 43′ 8″.1, moon's parallax = 60′ 23″.3, and R = 16′ 14″.8.

Hence Z — A = 17° 35′ 15″, a — A = — 19′ 34″.7, d — D = + 57′ 43″.4, and G = 60′ 14″.6.

With these values we obtain, p = — 3·0398, q = + 9·5787, r = 2·6965, u = + 2·3195, and v = + 8·6398.

The value of g, for the time T′, is + 6·80, and consequently (f + g) = + 4·44. This gives 0·0210 for the correction of r. Hence r' = 2·6755. The moon's semidiameter taken from Table VIII is 2·7315; consequently k = 5·4070. Then,

k = 5·4070	sq. 29·2357		$p - u$ = — 5·3593	sq. 28·7221
m	sq. 0·3700		$q - v$ = 0·9389	sq. 0·8815
h = 5·3727	sq. 28·8657			29·6036
h' = 5·4068			m	sq. 0·3700
Diff. = 0·0341			h' = 5·4068	sq. 29·2336

m. m. sec.
3·83 : 0·0341 : : 60 : 0·53 = 32

Hence the true time of beginning is 6 h. 0 m. 32 sec., in Greenwich mean time.

For the end take T′ = 8 h. 38 m. Then we shall find Z = 303° 32′ 52″.6, A = 246° 28′ 13″.3, D = — 21° 41′ 55″.3, a = 247° 42′ 41″.8, d = — 21° 7′ 4″·3, moon's parallax = 60′ 21″.6, and as before R = 16′ 14″.8. We also find g = 3·88, and consequently f + g = 1·52.

Hence p = + 11·5373, q = + 5·7414, r = 2·6975, r' = 2·6903, k = 5·4218, u = + 6·4435 and v = + 7·4782.

k = 5·4218	sq. 29·3959		$p - u$ = + 5·0938	sq. 25·9468
m	sq. 0·3700		$q - v$ = — 1·7368	sq. 3·0165
h = 5·3876	sq. 29·0259			28·9633
h' = 5·3473			m	sq. 0·3700
Diff. = 0·0403			h' = 5·3473	sq. 28·5933

m. m. sec.
4·57 : 0·0403 : : 60 : 0·53 = 32

Hence the true time of end is 8 h. 38 m. 32 sec. in Greenwich mean time. The true times of beginning and end, expressed in Philadelphia mean time, will be

	h.	m.	sec.
Beginning,	0	59	48
End,	3	37	48

It thus appears that in the present example the time of beginning, as found in the foregoing rule, differs only 12 seconds from the true time, and that the time of end exactly corresponds with that obtained by the exact calculation.

In these calculations no allowance has been made for irradiation and inflexion. To make this allowance we must diminish k, by subtracting from it the quotient of ten times the assumed value of these quantities, divided by the difference of the parallaxes in seconds. If we assume an irradiation and inflexion, amounting to $5''$, its effect in the present eclipse will be to make the time of beginning, at Philadelphia, 13 seconds later, and the time of end 11 seconds earlier than as above obtained. Thus we should have

	h.	m.	sec.
Beginning at	1	0	1
End at	3	37	37.

TABLE I.

Logarithms x and y.
Arg. Latitude of Place.

Arg.	Log. x.	Log. y.
0°	1·00000	0·99718
2	1·00000	0·99719
4	1·00001	0·99719
6	1·00002	0·99720
8	1·00003	0·99721
10	1·00004	0·99723
12	1·00006	0·99725
14	1·00008	0·99727
16	1·00011	0·99729
18	1·00013	0·99732
20	1·00016	0·99735
22	1·00020	0·99738
24	1·00023	0·99742
26	1·00027	0·99745
28	1·00031	0·99749
30	1·00035	0·99754
32	1·00039	0·99758
34	1·00044	0·99762
36	1·00048	0·99767
38	1·00053	0·99772
40	1·00058	0·99777
42	1·00063	0·99781
44	1·00068	0·99786
46	1·00073	0·99791
48	1·00078	0·99796
50	1·00082	0·99801
52	1·00087	0·99806
54	1·00092	0·99810
56	1·00097	0·99815
58	1·00101	0·99820
60	1·00105	0·99824
62	1·00110	0·99828
64	1·00114	0·99832
66	1·00117	0·99836
68	1·00121	0·99839
70	1·00124	0·99843
72	1·00127	0·99846
74	1·00130	0·99848
76	1·00133	0·99851
78	1·00135	0·99853
80	1·00137	0·99855
82	1·00138	0·99856
84	1·00139	0·99858
86	1·00140	0·99859
88	1·00141	0·99859
90	1·00141	0·99859

Note.—In the calculation of the above Table, the earth's compression was assumed to be $\frac{1}{309}$.

TABLE II.

Values of X and Y for each Degree of Latitude.

Lat.	X.	Y.	Lat.	X.	Y.
0°	10·00	0·00	45°	7·08	7·04
1	10·00	0·17	46	6·96	7·16
2	9·99	0·35	47	6·83	7·28
3	9·99	0·52	48	6·70	7·40
4	9·98	0·69	49	6·57	7·51
5	9·96	0·87	50	6·44	7·63
6	9·95	1·04	51	6·31	7·74
7	9·93	1·21	52	6·17	7·84
8	9·90	1·38	53	6·03	7·95
9	9·88	1·55	54	5·89	8·06
10	9·85	1·73	55	5·75	8·16
11	9·82	1·90	56	5·60	8·25
12	9·78	2·07	57	5·46	8·35
13	9·74	2·24	58	5·31	8·45
14	9·70	2·40	59	5·16	8·54
15	9·66	2·57	60	5·01	8·63
16	9·62	2·74	61	4·86	8·71
17	9·57	2·91	62	4·71	8·79
18	9·51	3·07	63	4.55	8·87
19	9·46	3·24	64	4·40	8·95
20	9·40	3·40	65	4·24	9·03
21	9·34	3·56	66	4·08	9·10
22	9·28	3·72	67	3·92	9·17
23	9·21	3·88	68	3·76	9·24
24	9·14	4·04	69	3·59	9·30
25	9·07	4·20	70	3·43	9·36
26	8 99	4·36	71	3·27	9·42
27	8·92	4·51	72	3·10	9·48
28	8·84	4·67	73	2·93	9·53
29	8·75	4·82	74	2·76	9·58
30	8·67	4·97	75	2·60	9·63
31	8·58	5·12	76	2·43	9·67
32	8·49	5·27	77	2·26	9·71
33	8·39	5·42	78	2·09	9·75
34	8·30	5·56	79	1·91	9·78
35	8·20	5·70	80	1·74	9·81
36	8·10	5·85	81	1·57	9·84
37	8·00	5·99	82	1·40	9·87
38	7·89	6·12	83	1·22	9·89
39	7·78	6·26	84	1·05	9·91
40	7·67	6·39	85	0·87	9·93
41	7·56	6·53	86	0·70	9·94
42	7·44	6·66	87	0·53	9·95
43	7·32	6·79	88	0·35	9·96
44	7·20	6·91	89	0·18	9·97
45	7·08	7·04	90	0·00	9·97

TABLE III.

Values of u′ and v′.
Arg. C for u′.
Arg. E for v′.

Arg.	u' or v'	Arg.	u' or v'
0·0	0·00	5·0	1·31
0·1	0·03	5·1	1·34
0·2	0·05	5·2	1·36
0·3	0·08	5·3	1·39
0·4	0·10	5·4	1·41
0·5	0·13	5·5	1·44
0·6	0·15	5·6	1·47
0·7	0·18	5·7	1·49
0·8	0·21	5·8	1·52
0·9	0·24	5·9	1·54
1·0	0·26	6·0	1·57
1·1	0·29	6·1	1·60
1·2	0·31	6·2	1·62
1·3	0·34	6·3	1·65
1·4	0·37	6·4	1·68
1·5	0·39	6·5	1·70
1·6	0·42	6·6	1·73
1·7	0·45	6·7	1·75
1·8	0·47	6·8	1·78
1·9	0·50	6·9	1·81
2·0	0·52	7.0	1·83
2·1	0·55	7·1	1·86
2·2	0·58	7·2	1·88
2·3	0·60	7·3	1·91
2·4	0·63	7·4	1·94
2·5	0·65	7·5	1·96
2·6	0·68	7·6	1·99
2·7	0·71	7·7	2·02
2·8	0·73	7·8	2·04
2·9	0·76	7·9	2·07
3·0	0·79	8·0	2·09
3·1	0·81	8·1	2·12
3·2	0·84	8·2	2·15
3·3	0·86	8·3	2·17
3·4	0·89	8·4	2·20
3·5	0·92	8·5	2·23
3·6	0·94	8·6	2·25
3·7	0·97	8·7	2·28
3·8	0·99	8·8	2·30
3·9	1·02	8·9	2·33
4·0	1·05	9·0	2·36
4·1	1·07	9·1	2·38
4·2	1·10	9·2	2·41
4·3	1·13	9·3	2·43
4·4	1·15	9·4	2·46
4·5	1·18	9·5	2·49
4·6	1·20	9·6	2·51
4·7	1·23	9·7	2·54
4·8	1·26	9·8	2.57
4·9	1·28	9·9	2·59
5·0	1·31	10·0	2·62

TABLE IV.

Squares of Numbers to two Decimal Places.

Root.	Square.	Root.	Square.	Root.	Square.	Root.	Square.	Root.	Square.	Root.	Square.
0·00	0·00	0·60	0·36	1·20	1·44	1·80	3·24	2·40	5·76	3·00	9.00
0·01	0·00	0·61	0·37	1·21	1·46	1·81	3·28	2 41	5·81	3·01	·9·06
0·02	0·00	0·62	0·38	1·22	1·49	1·82	3·31	2·42	5·86	3·02	9·12
0·03	0·00	0·63	0·40	1·23	1·51	1·83	3·35	2·43	5·90	3·03	9·18
0·04	0·00	0·64	0·41	1·24	1·54	1·84	3·39	2·44	5·95	3·04	9·24
0·05	0·00	0·65	0·42	1·25	1·56	1·85	3·42	2·45	6·00	3·05	9·30
0·06	0·00	0·66	0·44	1·26	1·59	1·86	3·46	2 46	6·05	3·06	9·36
0·07	0·00	0·67	0·45	1·27	1·61	1·87	3·50	2·47	6·10	3·07	9·42
0·08	0·01	0·68	0·46	1·28	1·64	1·88	3·53	2·48	6·15	3·08	9·49
0·09	0·01	0·69	0·48	1·29	1·66	1·89	3·57	2·49	6·20	3·09	9·55
0·10	0·01	0·70	0·49	1·30	1·69	1·90	3·61	2·50	6·25	3·10	9·61
0·11	0·01	0·71	0·50	1·31	1·72	1·91	3·65	2·51	6·30	3·11	9·67
0·12	0·01	0·72	0·52	1·32	1·74	1·92	3·69	2·52	6·35	3·12	9·73
0·13	0·02	0·73	0·53	1·33	1·77	1·93	3·72	2·53	6·40	3·13	9·80
0·14	0·02	0·74	0·55	1·34	1·80	1·94	3·76	2·54	6·45	3·14	9·86
0·15	0·02	0·75	0·56	1·35	1·82	1·95	3·80	2·55	6·50	3·15	9·92
0·16	0·03	0·76	0·58	1·36	1·85	1·96	3·84	2·56	6·55	3·16	9·99
0·17	0·03	0·77	0·59	1·37	1·88	1·97	3·88	2·57	6·60	3·17	10·05
0·18	0·03	0·78	0·61	1·38	1·90	1·98	3·92	2·58	6·66	3·18	10·11
0·19	0·04	0·79	0·62	1·39	1·93	1·99	3·96	2·59	6·71	3·19	10·18
0·20	0·04	0·80	0·64	1·40	1·96	2.00	4·00	2·60	6·76	3·20	10·24
0·21	0·04	0·81	0·66	1·41	1·99	2·01	4·04	2·61	6·81	3·21	10·30
0·22	0·05	0·82	0·67	1·42	2·02	2·02	4·08	2·62	6·86	3·22	10·37
0·23	0·05	0·83	0·69	1·43	2·04	2·03	4·12	2·63	6·92	3·23	10·43
0·24	0·06	0·84	0·71	1·44	2·07	2·04	4·16	2·64	6·97	3·24	10·50
0·25	0·06	0·85	0·72	1·45	2·10	2·05	4·20	2·65	7·02	3·25	10 56
0·26	0·07	0·86	0·74	1·46	2·13	2·06	4·24	2·66	7·08	3·26	10·63
0·27	0·07	0·87	0·76	1·47	2·16	2·07	4·28	2·67	7·13	3·27	10·69
0·28	0·08	0·88	0·77	1·48	2·19	2·08	4·33	2·68	7·18	3·28	10·76
0·29	0·08	0·89	0·79	1·49	2·22	2·09	4·37	2·69	7·24	3·29	10·82
0·30	0·09	0·90	0·81	1·50	2·25	2·10	4·41	2·70	7·29	3·30	10·89
0·31	0·10	0·91	0·83	1·51	2·28	2·11	4·45	2·71	7·34	3·31	10·96
0·32	0·10	0·92	0·85	1·52	2·31	2·12	4·49	2·72	7·40	3·32	11·02
0·33	0·11	0·93	0·86	1·53	2·34	2·13	4·54	2·73	7·45	3·33	11·09
0·34	0·12	0·94	0·88	1·54	2·37	2·14	4·58	2·74	7·51	3·34	11·16
0·35	0·12	0·95	0·90	1·55	2·40	2·15	4·62	2·75	7·56	3·35	11·22
0·36	0·13	0·96	0·92	1·56	2·43	2·16	4·67	2·76	7·62	3·36	11·29
0·37	0·14	0·97	0·94	1·57	2·46	2·17	4·71	2·77	7·67	3·37	11·36
0·38	0·14	0·98	0·96	1·58	2·50	2·18	4·75	2·78	7·73	3·38	11·42
0·39	0·15	0·99	0·98	1·59	2·53	2·19	4·80	2·79	7·78	3·39	11·49
0·40	0·16	1·00	1·00	1·60	2·56	2·20	4·84	2·80	7·84	3·40	11·56
0·41	0·17	1·01	1·02	1·61	2·59	2·21	4·88	2·81	7·90	3·41	11·63
0·42	0·18	1·02	1·04	1·62	2·62	2·22	4·93	2·82	7·95	3·42	11·70
0·43	0·18	1·03	1·06	1·63	2·66	2·23	4·97	2.83	8·01	3·43	11·76
0·44	0·19	1·04	1·08	1·64	2·69	2·24	5·02	2·84	8·07	3·44	11·83
0·45	0·20	1·05	1·10	1·65	2·72	2·25	5·06	2·85	8·12	3·45	11·90
0·46	0·21	1·06	1·12	1·66	2·76	2·26	5,11	2·86	8·18	3·46	11·97
0·47	0·22	1·07	1·14	1·67	2·79	2·27	5·15	2·87	8·24	3·47	12·04
0·48	0·23	1·08	1·17	1 68	2·82	2·28	5·20	2·88	8·29	3·48	12·11
0·49	0·24	1·09	1·19	1·69	2·86	2·29	5·24	2·89	8·35	3·49	12·18
0·50	0·25	1·10	1·21	1·70	2·89	2·30	5·29	2·90	8·41	3·50	12·25
0·51	0·26	1·11	1·23	1·71	2·92	2·31	5·34	2·91	8·47	3·51	12·32
0·52	0·27	1·12	1·25	1 72	2·96	2·32	5·38	2·92	8·53	3·52	12·39
0·53	0·28	1·13	1·28	1·73	2·99	2·33	5·43	2·93	8·58	3·53	12·46
0·54	0·29	1·14	1·30	1·74	3·03	2·34	5·48	2·94	8·64	3·54	12 53
0·55	0·30	1·15	1·32	1·75	3·06	2·35	5·52	2·95	8·70	3·55	12·60
0·56	0·31	1·16	1·35	1·76	3·10	2·36	5·57	2·96	8·76	3·56	12·67
0·57	0·32	1·17	1·37	1·77	3·13	2·37	5·62	2·97	8·82	3·57	12·74
0·58	0·34	1 18	1·39	1·78	3·17	2·38	5·66	2·98	8·88	3·58	12·82
0·59	0·35	1·19	1·42	1·79	3·20	2·39	5·71	2·99	8·94	3·59	12·89
0·60	0·36	1·20	1·44	1·80	3·24	2·40	5·76	3·00	9·00	3·60	12·96

TABLE IV. CONTINUED.

Squares of Numbers to two Decimal Places.

Root.	Square.	Root.	Square.	Root.	Square.	Root.	Square.	Root.	Square.
3·60	12·96	4·20	17·64	4·80	23·04	5·40	29·16	6·00	36·00
3·61	13·03	4·21	17·72	4·81	23·14	5·41	29·27	6·01	36·12
3·62	13·10	4·22	17·81	4·82	23·23	5·42	29·38	6·02	36·24
3·63	13·18	4·23	17·89	4·83	23·33	5·43	29·48	6·03	36·36
3·64	13·25	4·24	17·98	4·84	23·43	5·44	29·59	6·04	36·48
3·65	13·32	4·25	18·06	4·85	23·52	5·45	29·70	6·05	36·60
3.66	13·40	4·26	18·15	4·86	23·62	5·46	29·81	6·06	36·72
3·67	13·47	4·27	18·23	4·87	23·72	5·47	29·92	6 07	36 84
3·68	13·54	4·28	18·32	4·88	23·81	5·48	30·03	6·08	36·97
3·69	13·62	4·29	18·40	4·89	23·91	5·49	30·14	6·09	37·09
3·70	13·69	4·30	18·49	4·90	24·01	5·50	30·25	6·10	37·21
3·71	13·76	4·31	18·58	4·91	24·11	5·51	30·36	6·11	37·33
3·72	13·84	4·32	18·66	4·92	24·21	5·52	30·47	6·12	37·45
3·73	13·91	4·33	18·75	4·93	24·30	5·53	30·58	6·13	37·58
3·74	13·99	4·34	18·84	4·94	24·40	5·54	30·69	6·14	37·70
3·75	14·06	4·35	18·92	4·95	24·50	5·55	30·80	6·15	37·82
3·76	14·14	4·36	19·01	4·96	24·60	5·56	30·91	6·16	37·95
3·77	14·21	4·37	19·10	4·97	24·70	5·57	31·02	6·17	38·07
3·78	14·29	4·38	19·18	4·98	24·80	5·58	31·14	6·18	38·19
3·79	14·36	4·39	19·27	4·99	24·90	5·59	31·25	6·19	38·32
3·80	14·44	4·40	19·36	5·00	25·00	5·60	31·36	6·20	38·44
3·81	14·52	4·41	19.45	5·01	25·10	5·61	31·47	6·21	38·56
3·82	14·59	4·42	19·54	5·02	25·20	5·62	31·58	6·22	38·69
3·83	14·67	4·43	19·62	5·03	25·30	5·63	31·70	6·23	38·81
3·84	14·75	4·44	19·71	5·04	25·40	5·64	31·81	6·24	38·94
3·85	14·82	4·45	19·80	5·05	25·50	5·65	31·92	6·25	39·06
3·86	14.90	4·46	19·89	5·06	25·60	5·66	32·04	6·26	39·19
3·87	14·98	4·47	19·98	5·07	25·70	5·67	32·15	6·27	39·31
3.88	15·05	4·48	20·07	5·08	25·81	5·68	32·26	6·28	39·44
3·89	15·13	4·49	20·16	5·09	25·91	5,69	32·38	6·29	39·56
3·90	15·21	4·50	20·25	5·10	26·01	5·70	32·49	6·30	39·69
3·91	15·29	4·51	20·34	5·11	26·11	5·71	32·60	6·31	39·82
3·92	15·37	4·52	20·43	5·12	26·21	5·72	32·72	6·32	39·94
3·93	15·44	4·53	20·52	5·13	26·32	5·73	32·83	6·33	40·07
3·94	15·52	4·54	20·61	5·14	26·42	5·74	32·95	6·34	40·20
3·95	15·60	4·55	20·70	5·15	26·52	5·75	33·06	6·35	40·32
3·96	15·68	4·56	20·79	5·16	26·63	5·76	33·18	6·36	40·45
3·97	15·76	4·57	20·88	5·17	26·73	5·77	33·29	6·37	40·58
3·98	15·84	4·58	20·98	5·18	26·83	5·78	33·41	6·38	40·70
3·99	15·92	4·59	21·07	5·19	26·94	5·79	33·52	6·39	40·83
4·00	16·00	4·60	21·16	5·20	27·04	5·80	33·64	6·40	40·96
4·01	16·08	4·61	21·25	5·21	27·14	5·81	33·76	6·41	41·09
4·02	16·16	4·62	21·34	5·22	27·25	5·82	33·87	6·42	41·22
4·03	16·24	4·63	21·44	5·23	27·35	5·83	33·99	6·43	41·34
4·04	16·32	4·64	21·53	5·24	27·46	5·84	34·11	6·44	41·47
4·05	16·40	4·65	21·62	5·25	27·56	5·85	34·22	6·45	41·60
4·06	16·48	4·66	21·72	5·26	27·67	5·86	34·34	6·46	41·73
4·07	16·56	4·67	21·81	5·27	27·77	5·87	34·46	6·47	41·86
4·08	16·65	4·68	21·90	5·28	27·88	5·88	34·57	6·48	41·99
4·09	16·73	4·69	22·00	5·29	27·98	5 89	34·69	6·49	42·12
4·10	16·81	4·70	22.09	5·30	28·09	5·90	34·81	6·50	42·25
4·11	16·89	4·71	22·18	5·31	28·20	5·91	34·93	6·51	42·38
4·12	16·97	4·72	22 28	5·32	28·30	5·92	35·05	6·52	42·51
4·13	17·06	4·73	22·37	5·33	28·41	5·93	35·16	6·53	42·64
4·14	17·14	4·74	22·47	5·34	28·52	5·94	35·28	6·54	42·77
4·15	17·22	4·75	22·56	5·35	28·62	5·95	35·40	6·55	42·90
4·16	17·31	4·76	22·66	5·36	28·73	5·96	35·52	6·56	43·03
4·17	17·39	4·77	22·75	5·37	28·84	5·97	35·64	6·57	43·16
4·18	17·47	4·78	22·85	5·38	28·94	5·98	35·76	6·58	43·30
4·19	17·56	4·79	22·94	5·39	29·05	5·99	35·88	6·59	43·43
4·20	17·64	4·80	23·04	5·40	29·16	6·00	36·00	6·60	43·56

TABLE IV. CONTINUED.

Squares of Numbers to two Decimal Places.

Root.	Square.	Root.	Square.	Root.	Square.	Root.	Square.
6·60	43·56	7·20	51·84	7·80	60·84	8·40	70·56
6·61	43·69	7·21	51·98	7·81	61·00	8·41	70·73
6·62	43·82	7·22	52·13	7·82	61·15	8·42	70·90
6·63	43·96	7·23	52·27	7·83	61·31	8·43	71·06
6·64	44·09	7·24	52·42	7·84	61·47	8·44	71·23
6·65	44·22	7·25	52·56	7·85	61·62	8·45	71·40
6·66	44·36	7·26	52·71	7·86	61·78	8·46	71·57
6·67	44·49	7·27	52·85	7·87	61·94	8·47	71·74
6·68	44·62	7·28	53·00	7·88	62·09	8·48	71·91
6·69	44·76	7·29	53·14	7·89	62·25	8·49	72·08
6·70	44·89	7·30	53·29	7·90	62·41	8·50	72·25
6·71	45·02	7·31	53 44	7·91	62·57	8·51	72·42
6·72	45·16	7·32	53·58	7·92	62·73	8·52	72·59
6·73	45·29	7·33	53·73	7 93	62·88	8·53	72·76
6·74	45·43	7·34	53·88	7·94	63 04	8·54	72·93
6·75	45·56	7·35	54·02	7·95	63·20	8·55	73·10
6·76	45·70	7·36	54·17	7·96	63·36	8·56	73·27
6·77	45·83	7·37	54·32	7·97	63·52	8·57	73·44
6·78	45·97	7·38	54·46	7·98	63·68	8·58	73·62
6·79	46·10	7·39	54·61	7.99	63·84	8·59	73·79
6·80	46·24	7.40	54·76	8·00	64·00	8·60	73·96
6·81	46·38	7·41	54·91	8·01	64·16	8·61	74·13
6·82	46·51	7·42	55·06	8·02	64·32	8·62	74·30
6·83	46·65	7·43	55·20	8·03	64·48	8·63	74·48
6·84	46·79	7·44	55·35	8·04	64·64	8·64	74·65
6·85	46·92	7·45	55·50	8·05	64·80	8·65	74·82
6·86	47·06	7·46	55·65	8·06	64·96	8·66	75·00
6·87	47·20	7·47	55·80	8·07	65·12	8·67	75·17
6·88	47·33	7·48	55·95	8·08	65·29	8·68	75·34
6·89	47·47	7·49	56·10	8·09	65·45	8·69	75·52
6·90	47·61	7·50	56·25	8·10	65·61	8·70	75·69
6·91	47·75	7·51	56·40	8·11	65·77	8·71	75·86
6·92	47·89	7·52	56·55	8·12	65·93	8·72	76·04
6·93	48·02	7·53	56·70	8·13	66·10	8·73	76·21
6·94	48·16	7·54	56·85	8·14	66 26	8·74	76·39
6·95	48·30	7·55	57·00	8·15	66·42	8·75	76·56
6·96	48·44	7·56	57·15	8·16	66·59	8·76	76·74
6·97	48·58	7·57	57·30	8·17	66·75	8·77	76·91
6·98	48·72	7·58	57·46	8·18	66·91	8·78	77·09
6·99	48·86	7·59	57·61	8·19	67·08	8·79	77·26
7·00	49·00	7·60	57·76	8·20	67·24	8·80	77·44
7·01	49·14	7·61	57·91	8·21	67·40	8·81	77·62
7·02	49·28	7·62	58·06	8·22	67·57	8·82	77·79
7·03	49·42	7·63	58·22	8·23	67·73	8·83	77·97
7·04	49·56	7·64	58 37	8·24	67·90	8·84	78·15
7 05	49·70	7·65	58·52	8·25	68·06	8·85	78·32
7·06	49·84	7·66	58·68	8·26	68·23	8·86	78·50
7·07	49·98	7·67	58·83	8·27	68·39	8·87	78 68
7·08	50·13	7·68	58·98	8·28	68·56	8·88	78·85
7·09	50·27	7·69	59·14	8·29	68·72	8·89	79·03
7·10	50·41	7·70	59·29	8·30	68·89	8·90	79·21
7·11	50·55	7·71	59·44	8·31	69·06	8·91	79·39
7·12	50·69	7·72	59·60	8·32	69·22	8·92	79·57
7·13	50·84	7·73	59·75	8·33	69·39	8·93	79·74
7·14	50·98	7·74	59·91	8·34	69·56	8·94	79·92
7·15	51·12	7·75	60·06	8·35	69·72	8·95	80·10
7·16	51·27	7·76	60·22	8·36	69·89	8·96	80·28
7·17	51·41	7·77	60·37	8·37	70·06	8·97	80·46
7·18	51·55	7·78	60·53	8·38	70·22	8·98	80·64
7·19	51·70	7·79	60·68	8·39	70·39	8·99	80·82
7·20	51·84	7·80	60·84	8·40	70·56	9·00	81·00

TABLE V.

	Arg. $\frac{p-u}{q-v}$ or $\frac{u}{v}$		Arg. $\frac{q-v}{p-u}$ or $\frac{v}{u}$			Arg. $\frac{p-u}{q-v}$ or $\frac{u}{v}$		Arg. $\frac{q-v}{p-u}$ or $\frac{v}{u}$	
Arg.	Arg. +	Arg. —	Arg. +	Arg. —	Arg.	Arg. +	Arg. —	Arg. +	Arg. —
·00	0°·0	180°·0	90°·0	90°·0	·50	26°·6	153°·4	63°·4	116°·6
·01	0·6	179·4	89·4	90·6	·51	27·0	153·0	63·0	117·0
·02	1·1	178·9	88·9	91·1	·52	27·5	152·5	62·5	117·5
·03	1·7	178·3	88·3	91·7	·53	27·9	152·1	62·1	117·9
·04	2·3	177·7	87·7	92·3	·54	28·4	151·6	61·6	118·4
·05	2·9	177·1	87·1	92·9	·55	28·8	151·2	61·2	118·8
·06	3·4	176·6	86·6	93·4	·56	29·2	150·8	60·8	119·2
·07	4·0	176·0	86·0	94·0	·57	29·7	150·3	60·3	119·7
·08	4·6	175·4	85·4	94·6	·58	30·1	149·9	59·9	120·1
·09	5·1	174·9	84·9	95·1	·59	30 5	149·5	59·5	120·5
·10	5·7	174·3	84·3	95·7	·60	31·0	149·0	59·0	121·0
·11	6·3	173·7	83·7	96·3	·61	31·4	148·6	58·6	121·4
·12	6·8	173·2	83·2	96·8	62	31·8	148·2	58·2	121·8
·13	7·4	172·6	82·6	97·4	·63	32·2	147·8	57·8	122·2
·14	8·0	172·0	82·0	98·0	·64	32·6	147·4	57·4	122·6
·15	8·5	171·5	81·5	98·5	·65	33·0	147·0	57·0	123·0
·16	9·1	170·9	80·9	99·1	·66	33·4	146·6	56·6	123·4
·17	9·6	170·4	80·4	99·6	·67	33·8	146·2	56·2	123·8
·18	10·2	169·8	79·8	100·2	·68	34·2	145·8	55·8	124·2
·19	10·8	169·2	79·2	100·8	·69	34·6	145·4	55·4	124·6
·20	11·3	168·7	78·7	101·3	·70	35·0	145·0	55·0	125·0
·21	11·9	168·1	78·1	101·9	·71	35·4	144·6	54·6	125·4
·22	12·4	167·6	77·6	102·4	·72	35·8	144·2	54·2	125·8
·23	13·0	167·0	77·0	103·0	·73	36·1	143·9	53·9	126·1
·24	13·5	166·5	76·5	103·5	·74	36·5	143·5	53·5	126·5
·25	14·0	166·0	76·0	104·0	·75	36·9	143·1	53·1	126·9
·26	14·6	165·4	75·4	104·6	·76	37·2	142·8	52·8	127·2
·27	15·1	164·9	74·9	105·1	·77	37·6	142·4	52·4	127·6
·28	15·6	164·4	74·4	105·6	·78	38·0	142·0	52·0	128·0
·29	16·2	163·8	73·8	106·2	·79	38·3	141·7	51·7	128·3
·30	16·7	163·3	73·3	106·7	·80	38·7	141·3	51·3	128·7
·31	17·2	162·8	72·8	107·2	·81	39·0	141·0	51·0	129·0
·32	17·7	162·3	72·3	107·7	·82	39·4	140·6	50·6	129·4
·33	18·3	161·7	71·7	108·3	·83	39·7	140·3	50·3	129·7
·34	18·8	161·2	71·2	108·8	·84	40·0	140·0	50·0	130·0
·35	19·3	160·7	70·7	109·3	·85	40·4	139·6	49·6	130·4
·36	19·8	160·2	70·2	109·8	·86	40·7	139·3	49·3	130·7
·37	20·3	159·7	69·7	110·3	·87	41·0	139·0	49·0	131·0
·38	20·8	159·2	69·2	110·8	·88	41·3	138·7	48·7	131·3
·39	21·3	158·7	68·7	111·3	·89	41·7	138·3	48·3	131·7
·40	21·8	158·2	68·2	111·8	·90	42·0	138·0	48·0	132·0
·41	22·3	157·7	67·7	112·3	·91	42·3	137·7	47·7	132·3
·42	22·8	157·2	67·2	112·8	·92	42·6	137·4	47·4	132·6
·43	23·3	156·7	66·7	113·3	·93	42·9	137·1	47·1	132·9
·44	23·7	156·3	66·3	113·7	·94	43·2	136·8	46·8	133·2
·45	24·2	155·8	65·8	114·2	·95	43·5	136·5	46·5	133·5
·46	24·7	155·3	65·3	114·7	·96	43·8	136·2	46·2	133·8
·47	25·2	154·8	64·8	115·2	·97	44·1	135·9	45·9	134·1
·48	25·6	154·4	64·4	115·6	·98	44·4	135·6	45·6	134·4
·49	26·1	153·9	63·9	116·1	·99	44·7	135·3	45·3	134·7
·50	26·6	153·4	63·4	116·6	1·00	45·0	135·0	45·0	135·0

TABLE VI.

Values of u and C *for Latitude of Philadelphia.*
Arg. *The Hour Angle* H.

Arg.	Arg.	u.	C.	Arg.	Arg.
180°	0°	0·00	7·68	90°	90°
179	1	0·13	7·68	89	91
178	2	0·27	7·67	88	92
177	3	0·40	7·67	87	93
176	4	0·54	7·66	86	94
175	5	0·67	7·65	85	95
174	6	0·80	7·63	84	96
173	7	0·93	7·62	83	97
172	8	1·07	7·60	82	98
171	9	1·20	7·58	81	99
170	10	1·33	7·56	80	100
169	11	1·46	7·54	79	101
168	12	1·60	7·51	78	102
167	13	1·73	7·48	77	103
166	14	1·86	7·45	76	104
165	15	1·99	7·41	75	105
164	16	2·12	7·38	74	106
163	17	2·24	7·34	73	107
162	18	2·37	7·30	72	108
161	19	2·50	7·26	71	109
160	20	2·63	7·21	70	110
159	21	2·75	7·17	69	111
158	22	2·88	7·12	68	112
157	23	3·00	7·07	67	113
156	24	3·12	7·01	66	114
155	25	3·24	6·96	65	115
154	26	3·36	6·90	64	116
153	27	3·48	6·84	63	117
152	28	3·60	6·78	62	118
151	29	3·72	6·71	61	119
150	30	3·84	6·65	60	120
149	31	3·95	6·58	59	121
148	32	4·07	6·51	58	122
147	33	4·18	6·44	57	123
146	34	4·29	6·36	56	124
145	35	4·40	6·29	55	125
144	36	4·51	6·21	54	126
143	37	4·62	6·13	53	127
142	38	4·73	6·05	52	128
141	39	4·83	5·97	51	129
140	40	4·93	5·88	50	130
139	41	5·04	5·79	49	131
138	42	5·14	5·70	48	132
137	43	5·24	5·61	47	133
136	44	5·33	5·52	46	134
135	45	5·43	5·43	45	135
		C.	u.		

TABLE VII.

Values of b and f for Latitude of Philadelphia.
Arg. *Sun's or Star's Declin.*

Arg.	b.	f.
0°	6·39	0·00
1	6·39	0·11
2	6·38	0·22
3	6·38	0·33
4	6·37	0·45
5	6·36	0·56
6	6·35	0·67
7	6·34	0·78
8	6·33	0·89
9	6·31	1·00
10	6·29	1·11
11	6·27	1·22
12	6·25	1·33
13	6·22	1·44
14	6·20	1·55
15	6·17	1·65
16	6·14	1·76
17	6·11	1·87
18	6·08	1·97
19	6·04	2·08
20	6·00	2·18
21	5·96	2·29
22	5·92	2·39
23	5·88	2·50
24	5·84	2·60
25	5·79	2·70
26	5·74	2·80
27	5·69	2·90
28	5·64	3·00
29	5·59	3·10
30	5·53	3·19

TABLE VIII.

Moon's reduced Semidiameter.
Arg. *Moon's Horizontal Parallax.*

Arg.	Semidiam.
53′	2·7324
54	2·7323
55	2·7321
56	2·7320
57	2·7319
58	2·7318
59	2·7316
60	2·7315
61	2·7314
62	2·7313

TABLE IX.

Correction of r, the Sun's Reduced Semidiameter.
Arguments, $(f + g)$ *at the Top, and Sun's Semidiameter at the Side.*

	1	2	3	4	5	6	7	8	9	10
15′ 46″	·0046	·0092	·0138	·0184	·0230	·0276	·0322	·0368	·0414	·0460
48	46	92	38	84	30	76	23	69	15	61
15 50	·0046	·0092	·0139	·0185	·0231	·0277	·0323	·0369	·0416	·0462
52	46	93	39	85	31	78	24	70	16	63
54	46	93	39	85	32	78	25	71	17	64
56	46	93	39	86	32	79	25	72	18	65
58	47	93	40	86	33	79	26	72	19	66
16 0	·0047	·0093	·0140	·0187	·0233	·0280	·0327	·0373	·0420	·0467
2	47	94	40	87	34	81	27	74	21	68
4	47	94	41	87	34	81	28	75	22	68
6	47	94	41	88	35	82	29	76	23	69
8	47	94	41	88	35	82	29	76	23	70
16 10	·0047	·0094	·0141	·0189	·0236	·0283	·0330	·0377	·0424	·0471
12	47	94	42	89	36	83	31	78	25	72
14	47	95	42	89	37	84	31	79	26	73
16	47	95	42	90	37	85	32	80	27	74
18	48	95	43	90	38	85	33	80	28	75

ARTICLE XIV.

Contributions to the Geology of the Tertiary Formations of Virginia. By William B. Rogers, Professor of Natural Philosophy in the University of Virginia, and Henry D. Rogers, Professor of Geology in the University of Pennsylvania. Read May 5th, 1835.

I. GEOLOGY OF A PORTION OF THE PENINSULA BETWEEN THE JAMES AND YORK RIVERS.

1. The region of which we are about to treat, comprises the counties of Elizabeth City, Warwick, York and James City, and the lower extremities of New Kent and Charles City counties. Its length in a north west direction is about fifty, and its mean breadth about fourteen miles. In Elizabeth City and Warwick counties, and the eastern portion of York county, the general level of the surface is but little elevated above tide. The country is a uniform flat, in some places subject to be occasionally overflowed. The rest of the region in question has an elevation above tide, varying from twenty to eighty feet. But few points, however, in the district have a level corresponding to either of these extremes, and by far the larger portion of the surface preserves a height of from forty to fifty feet.

2. The surface of this more elevated portion, though preserving a general level of remarkable uniformity, is deeply channelled by innumerable ravines. The smaller of these connect themselves with large ones, and these with the wider and deeper excavations forming

the beds of the creeks flowing into the James and York rivers. The system of ravines connected with one river, are separated by a narrow central tract from those connected with the other, and in a general view of the district, the two systems present the appearance of mere creeks or inlets, subordinate to the two great rivers bounding the peninsula.

3. The superficial stratum of the region we are describing is an argillaceous and ferruginous sand, of a yellow, and sometimes of a reddish colour, in which are occasionally found, at or near the surface, pebbles and small boulders of sandstone, rarely as much as six inches in diameter. The nature of these boulders would indicate that they were most probably derived from the sandstone formation which ranges along the eastern boundary of the primary ridge. In some places this stratum consists of little else than a white silicious sand; in others, the admixture of ochreous clay is so considerable, as to furnish a suitable material for the manufacture of bricks.

4. Beneath this superficial layer, beds of a very argillaceous clay occasionally occur, sometimes of considerable depth and extent, and of a texture to be useful in puddling. Its colour is various, being in some places a dark blue or green, in others a bright red or dingy yellow. Wherever found, its upper boundary is remarkably even and horizontal; but where it rests upon beds of fossil shells, its lower limit conforms to all the irregularities of surface which those beds usually present. Its appearance, in some places, is that of a steep, almost perpendicular wall of smooth surface, and divided by very narrow lines running horizontally. These narrow lines, at a distance of from five inches to a foot asunder, are formed by a more ferruginous and silicious clay. At Bellefield, on the York river, seven miles from Williamsburg, this deposit may be seen overlying the stratum containing shells, in some places having a thickness of from twelve to fifteen feet, and then gradually fining out and passing into a light coloured and coarser mass. The upper surface is horizontal, and the lines of division above alluded to are perfectly parallel and regular. The lower surface of the clay conforms to that of the shell stratum upon which it rests. In many places these argillaceous beds consist of a yellowish clay, beautifully variegated by streaks of red and blue.

5. A thin stratum of red ferruginous stone, containing a large proportion of oxide of iron, is found in this region, running horizontally below the beds of clay before described, and generally separated by only a few feet from the underlying masses of shells. This stratum, which is very generally present, varies in thickness from an inch to a foot. Its texture is sometimes cellular, sometimes compact and fibrous, like that of certain varieties of hematite.

6. The matter, which, in most cases, rests immediately upon the shells, is a yellowish brown sand, frequently containing a large proportion of clay. Throughout this mass, and often extending to the distance of five or six feet from the shells, particles of green sand, or the silicate of iron and potash, are more or less abundantly disseminated, and in the immediate vicinity of the shells these particles are generally condensed into narrow stripes, conforming in flexure to the irregularities of the bed beneath. Even where a deep hole exists in the layer of shells, the stripes of green sand are seen still following the depression and rise of the surface, and preserving a uniform distance from it. Sometimes these thin layers are so much indurated as to have almost the appearance of stone. In none of the strata above described have fossils of any description ever been discovered.

7. The materials with which the shells are intermixed, or in which they are embedded, have various characters. In some cases they consist principally of a nearly white sand; in others the argillaceous matter greatly predominates, and the mass is a somewhat tenacious clay. Frequently much oxide of iron is mingled with the earthy matter, giving it more or less of a yellow or brown appearance, and this is the aspect which the upper beds containing shells most usually present. Very generally the lowest visible fossiliferous stratum is composed of a green silicious sand, and a bluish clay, which being always very moist, is soft and tenacious, and presents a dark blue or black colour. At the base of the cliffs on the James and York rivers, this stratum may be traced continuously for considerable distances, rarely rising more than two or three feet above the level of the water, and presenting an even horizontal outline. In the deep ravines, and low down in the banks of shells, generally, throughout this region, a

similar dark bluish-green argillaceous sand is observed, enclosing frequently a great number and variety of shells.

The very general existence of the lower stratum, here described, forms an interesting and prominent feature in the geology of the Miocene Tertiary districts, as well of eastern Virginia as of Maryland. Throughout all the upper fossiliferous strata, as well as in the argillaceous beds just mentioned, will be found disseminated, greenish-black grains of silicate of iron and potash, identical with those already described as existing in the stratum immediately overlying the shells, and having the same form and composition with the granules contained very abundantly in an older Formation, both in this country and Europe. In some beds of the marl, or shells, these particles so abound as to give a very decided colour to the whole mass. In specimens from James City and York counties, as much as thirty-five per cent of the green sand has been found, and occasionally shells are seen filled with this substance almost alone.

7. The surface of the strata containing shells is usually irregular. Sometimes it rises abruptly, in the form of a hillock; then it is scooped out into depressions of a few feet in depth. These irregularities, however, are apparently of two kinds; the one the original form of the deposit, the other produced by denuding action upon the surface. Thus in many places the same stratum may be remarked rising with more or less abruptness; then again descending, and perhaps preserving a nearly horizontal line for some distance, marked at its upper surface by a clear and unbroken outline, and presenting no indication of violent abrasion from above. In other places, and this is a very frequent occurrence, deep and irregular furrows and cavities are seen, such as would naturally arise from the action of the currents and eddies of a large mass of water in rapid movement.

8. Having thus given an account of the nature and arrangement of the strata overlying the shells, as well as those in which they are imbedded, we will now describe the general condition and disposition in which the shells occur.

9. Condition of the shells in the tertiary deposits.

In general, the state of the shells, and their arrangement in the earth, are such as to indicate their tranquil deposition at the spots in which they are found. Thus the corresponding valves are very often found together and closely shut. Many of the smaller shells, such as Arca centenaria, Arca incile, Nuculae, Venericardia alticosta, and Chama congregata, which are most usually thus found, are often either entirely empty, or contain a small quantity of clay that is quite impalpable; indicating plainly that they have been exposed to no violence, and that only such solid matter as could pass between the edges of the closed valves had obtained access to the interior. Whenever such shells, however, have been previously drilled, as is very frequently the case even with the largest and thickest shells, the interior is found entirely filled with sand, clay, green sand, and small fragments of shell. In most cases the larger species of shells, even when their valves appear to be in accurate juxtaposition, is thus filled, and in this case it cannot be supposed that the contained matter has entered through the holes thus drilled, since in many instances shells of considerable magnitude are found imprisoned within. Such shells, no doubt, after the death of the animal, remained open, or at least partially so, and received the sand, clay and other materials which they contain by the *gentle* action of the waves. The ligament at the hinge in the mean time would decay, until at length yielding to the pressure of the accumulating matter above the shell, in favourable circumstances would collapse into its natural closed condition.

The very common occurrence of the valves in juxtaposition, is a striking proof that during or subsequent to their deposition they have not been exposed to violent agencies. This becomes even more remarkable in the case of such shells as the Panopea reflexa, which almost in every instance is found with the valves properly united. The connection between the two valves in this shell is the slightest imaginable after the destruction of the natural organic bond, and an inconsiderable force would have sufficed to separate and break the valves.

10. The admirable preservation of the shells in many cases is also an interesting fact, and affords another evidence of the absence of all violent agencies at this period. The most fragile species of Natica, delicate Tellinae, Mactra tellinoides, the shell and processes of the Crepidula, the minute and sharp angles of the Fusus tetricus, the thin

and hollow Fissurella are found in perfect preservation in many places. The state of the shells seems to depend chiefly upon the mechanical texture and chemical character of the materials with which they are mixed, and of which the overlying stratum is composed. In the moist blue clay the shells are generally found in a very soft condition. In a highly ferruginous clayey bed they are found either partially or entirely dissolved, and beautiful casts remain in their stead.

11. In many places entire banks occur, composed of casts of Chama and other shells, sometimes separate, sometimes cemented together so as to form a species of rock. These appearances occur chiefly near the surface, and when the soil is porous and ferruginous. The casts thus formed often consist chiefly of carbonate of lime, and in many specimens as much as eighty per cent of this substance is found. Casts of this kind belong mostly to the smaller shells, and by far the most common are of the Chama congregata. These, as already stated, are often found nearly or quite empty, and we may, therefore, conceive, that as the matter of the shell in an extensive bank of Chamas is gradually dissolved, the water charged with carbonate of lime enters the cavities, and slowly deposits the carbonate mixed with fine particles of clay and sand. Thus by degrees the cavities are filled. In the mean time the shell disappears, frequently leaving on the surface of the cast a chalky covering, like the decomposed inner film of shelly matter. In support of this explanation it may be added, that in many casts beautiful crystals of carbonate of lime are found, forming a portion of the cast, and having the appearance of Dog-tooth Spar. In some cases the shelly matter appears to have been dissolved, and its place supplied by the crystallized carbonate, encrusting the earth formerly contained within the shell. Sometimes, too, a thin film of oxide of iron surrounds the cast, showing very distinctly all the markings of the inner surface of the shell. In many localities, presenting a series of beds differing in composition, the shells will be found perfect in some of them, while in others immediately above or below only casts remain. Thus at the College Mill, about one mile from Williamsburg, the upper fossiliferous layer is a yellow silicious sand, containing perfect shells. Below this is a brown *ferruginous* clay, filled with the most beautiful casts of Chama, Pectunculus, Turritella, &c.

The shelly matter has entirely disappeared, and the casts lie loosely in the cavities produced by the removal of the shells, entirely distinct from each other, and covered by a film of oxide of iron. The layer beneath, consisting of bluish-green silicious clay, is full of well preserved Pectens, Pernas, and a variety of other shells.

12. In general, the various species of shells are found associated in colonies or groups, but as in the case of banks of recent shells, these colonies contain many scattered specimens, differing from the general contents of the group. The two species of Chama, the C. congregata and C. corticosa, which are found in almost every deposit of shells in this region, in many cases form extensive beds, with a very small admixture of other genera. The best agricultural marl, of a purely calcareous nature, which is used in lower Virginia, is derived from these beds of Chama, the friable texture of the shell upon exposure to the air rendering this species of marl more easy of application to land, and more prompt in its ameliorating effects. Crassatellæ often form an extensive deposit, and the large Pectens occur in continuous layers of considerable depth and extent. The different species of Arca, Artemis, Crepidula, &c., present a similar arrangement. Even those shells which are of comparatively rare occurrence, are usually found in little groups. Thus the Isocardia fraterna is found, to the extent of a dozen or twenty, closely packed together. This gregarious assemblage of shells of the same species is what would naturally be anticipated in the absence of violent agencies during or after their deposition, and furnishes another very striking proof of the comparatively tranquil condition of the sea or estuary in which they were allowed to accumulate.

13. Disposition of the fossils.

In nearly all the vertical sections of the deposit we are now describing, a series of beds or strata may be observed, each distinguished by the predominance of one or more species, and the order of superposition of these beds frequently continues without interruption for some distance. It does not appear, however, that in localities remote from each other the arrangement of the shells is always alike, although in many instances there appears to be a striking correspondence. In a majority of cases in the neighbourhood of Williamsburg the upper layer is composed principally of Chama congregata. In many localities also, the large Pectens mingled with Ostrea Virginica occupy the highest place. But generally, the same shell reappears as a predominant constituent of one or more of the subjacent beds; and such is the diversity of arrangement, even in places but a few miles distant, that it is obvious that no general order of succession exists. Thus in a range of three miles we find Perna maxillata in some localities in the lowest stratum of dark blue argillaceous sand; in others, forming an upper or even the highest layer of the series. At Waller's Mill, three miles from Williamsburg, this fossil overlies the other shells; whereas at the College Mill, as already stated, it forms a part of the lowest visible stratum. So far, therefore, as relates to the tertiary beds of the district of which we are now treating, and indeed of Virginia generally, there is no such constancy in the position of this fossil in the series, as to warrant the theoretical inference of its belonging to a different tertiary period, deduced by Mr Conrad from its relation to the other tertiary fossils in certain districts in Maryland.

14. With the view of conveying more precise ideas of the disposition of the fossils in this region, as well as describing some interesting facts peculiar to certain districts which have been investigated, we annex the following details in relation to some of the more important localities.

15. King's Mill, one of the most interesting fossil localities in the neighbourhood of Williamsburg, is situated on the north bank of the James river, about twenty-five miles from its mouth. The cliff in which the shells appear is abrupt, and has a height varying from twenty to forty-five feet above the water. The strata of shells extend along the river with slight interruptions, when the cliff sinks nearly to the level of the water, for a distance of between two and three miles, and they are found in a somewhat similar order of superposition for some distance inland. Their general direction is horizontal, but the outline of any one stratum is frequently very irregular, the surface rising and falling with a steep inclination. This irregular outline is particularly remarkable with the beds of Chama, which are very thick at some points, and then fine out rapidly and again expand.

16. This deposit of shells is covered to the depth of from four to

six feet by a brownish yellow sand, intermixed with stripes of clay. Beneath this is a thin layer of about one foot, of very argillaceous and ferruginous clay of a red colour. This rests upon a few inches thickness of gravel, consisting of water-worn quartz, rarely larger than a pea. Beneath this is a layer, from one to two feet thick, consisting of yellow sand, containing a great deal of the green or chloritic sand, arranged in narrow stripes. Next follows a layer of the same sand, containing principally Chama and Venus deformis. This is from two to three feet in thickness. Immediately below is a stratum consisting almost exclusively of Chama, with a few Arca centenaria, &c. This stratum, varying from three to four feet in thickness, is a mass of compacted shells, with but little earthy matter intervening. The earthy matter contains a very large proportion of the chloritic sand. The next stratum is composed chiefly of large Pectens, and has a thickness of from one to two feet. Below this is another dense stratum of Chama, together with Arca centenaria, Panopea reflexa, &c., and also very rich in the green sand. Thickness, from four to six feet. Then follows a second layer containing Pectens with Ostrea compressirostra, one foot in thickness. A third stratum, in which Chama predominates, follows next, in thickness from two to three feet, and at the base of the cliff is a layer containing Pectens, Ostrea compressirostra, &c., four to five feet in thickness.

17. Thus through a height of more than twenty feet in some places, the cliff consists principally of shells, of which there are a great many species, besides those mentioned as predominating in the several beds. On the extensive contiguous estates of King's Mill and Littletown, these shells are largely used as a manure: and for this purpose the first and second beds of Chama are preferred on account of the immense amount of calcareous matter, and the large proportion of green sand which they contain. Judging from the occasional appearance of bluish green-clay on the line of the beach, and in some places immediately at the base of the cliff just described, it is highly probable that a continuous stratum of this substance lies beneath the other beds throughout the whole extent observed. A horizontal bed of yellowish clay extends for some distance along a lower portion of the cliff, in which there are no fossils, running within a few feet of its upper edge, and beneath this bed, and parallel to it, is a thin layer of the iron ore

formerly described. At the foot of this cliff appears the underlying stratum of clay.

18. Description of the cliffs at Yorktown, on the York river.

The elevation, abrupt form, and peculiar structure of the cliffs at this point, and for some distance both above and below, render it an interesting spot to the geologist. A dry and ample beach, uninterrupted by creeks or inlets for several miles, affords a ready access to the banks; while the river's edge, strewed with fossils which have fallen from the cliff, exposes a considerable variety of interesting specimens. Immediately at York, the river is only three-eighths of a mile in width, but both above and below, it expands to a breadth six or seven times as great.

At Wormley's creek, about two miles below the town, the cliff about to be described begins; but from this point down to the extremity of the peninsula, the banks are uniformly flat and low. The cliff here consists at bottom of a bluish sandy clay, containing immense numbers of Turritella alticosta, Cytherea Sayana, and many small univalves, over which lies a layer of brownish yellow sand, with very few shells, and those chiefly Nucula limatula and a few other species. To this succeeds a stratum composed almost entirely of Crepidula costata, so closely packed together as to leave little space for sand or other earthy matter. The whole is covered to a variable depth by a stratum of coarse sand of various strong tints, and evidently highly ferruginous. The elevation of the cliff increases, and the nature of its contents gradually changes, in approaching York. The lower stratum disappears entirely after continuing for something less than half a mile, previous to which, however, its fossil contents are changed; the layer of the Turritellæ being replaced by Crepidula closely packed together. Crepidula still runs on horizontally above, and the intermediate stratum is now densely filled with Pectens, Venus deformis, Ostrea, and a great variety of small shells frequently connected together so as to form hard masses of considerable size. Still higher up the river the deposit assumes the character of successive layers composed of comminuted shells, connected together so as to form a porous rock. These fragments are generally so small and so much rubbed and water-worn, as to render it impossible to ascertain the species of shell of which they once were portions. Many small shells, and occasionally large ones, particularly Pectens, are found mingled with the other constituents of the rocks; and in some places thin layers of shells, such as Venus and Crepidula, intervene between the adjacent strata. The height of this fragmentary rock amounts in some places to forty feet. In most places it has a highly ferruginous aspect, though this is not invariably the case. Frequently shells of considerable size, such as Lucina anodonta, are seen coated with, or entirely changed into, crystalline carbonate of lime, firmly cemented in the mass. The texture of the rock is various, at some points admitting of being readily excavated by the pick and spade, so as to form caves which have been occasionally used by the inhabitants; in other places exhibiting a hard and semi-crystalline structure, and having the compactness of some forms of secondary limestone. The lower portion of the cliff, having less cohesion than the rest, has been scooped out by the action of water so as to give it, occasionally, an impending attitude.

Above the town the stratum of fragmentary rock becomes much thinner, being now reduced to about ten or twelve feet. A stratum of yellowish argillaceous clay, abounding in Artemis acetabulum, Mactras and other large shells, lies immediately beneath the rock; and lower still, appears the stratum of bluish clay, filled with Nucula limatula, several species of Fusus, and various other fossils.

A narrow layer of iron ore extends along the cliff, with occasional interruptions, at a small distance above the fossiliferous strata.

19. This fragmentary rock continues in a narrow band, with some interruptions, for about a mile and a half above York. Beyond this point it is met with chiefly in detached masses. Extensive beds of shells, similar to those which appear at York, come to view in the vicinity of Bellefield, and line the shore for a distance of about three miles. These beds rest on the usual stratum of sandy clay, and are in some places, as already described, covered by a stratum of the same substance. At a still remoter point, about six miles above York, on Jones's plantation, a porous rocky mass occurs, overlying the stratum of shells in a thin and interrupted layer. Though very similar in appearance to the fragmentary mass before described, and evidently at one time composed of portions of shells, it is almost devoid of any trace

of carbonate of lime. It appears to consist of silex, slightly tinged with oxide of iron; approaching in its porous character and harsh gritty texture to the nature of the burr-stone of France. Associated with this is a more compact rock, containing some carbonate of lime, with much silex, and exhibiting very perfect casts and impressions of Pectens, Cardium, &c. Over these strata is the usual layer of iron-stone, and the general aspect of the upper beds is somewhat ferruginous.

20. It is interesting to remark that, with some interruptions, a fragmentary deposit similar to that observed at York extends to the lower extremity of the peninsula. At Pocosin, a flat swampy country, which is often inundated by the tides, this deposit is uniformly met with by digging a few feet below the surface. Pectunculus, Pecten, Ostrea, as well as numerous small shells, occur mingled with it, as at York; the fragments, however, are not cemented together, but form a loose friable mass.

21. A very interesting feature in the structure of the cliff at York remains to be described. Though the general direction of the fossil beds is nearly horizontal, several of the strata of rock are composed of transverse layers parallel to each other, generally dipping towards the north, and making an angle of fifteen or twenty degrees with the horizon. The course of these laminæ sometimes differs in adjoining strata, and in some places the obliquity diminishes gradually until the laminæ become horizontal; thus presenting a remarkable resemblance to the appearances described by Lyell and others as existing in the Crag of England. The phenomenon here described, viewed in connexion with the fragmentary structure of the rock, and the general distribution of broken shells over the lower extremity of the peninsula, would seem to indicate the former agency in this district of coast currents and an ocean surf.

22. At Burwell's Mill, and other localities in the immediate neighbourhood of Williamsburg, nearly the same fossils occur as at King's Mill and Yorktown. Besides shells and Zoophytes, in these and other places in the peninsula, the bones of cetaceous animals and the teeth of sharks are of very frequent occurrence in the fossiliferous beds, but no remains of fresh water or land animals have as yet been discovered.

The total number of species of shells from these points which have yet been identified is about ninety-six, to which we will now add the following *new* species, recently discovered by ourselves. To this list others believed to be new, and at present under examination, will hereafter be added.

II. DESCRIPTION OF SOME NEW MIOCENE FOSSIL SHELLS.

Turritella ter-striata. pl. 26

23. Whorls strongly angulated by three principal revolving elevated spiral ridges; the lowest, being about one-third from the base, is the most prominent; the second, which closely adjoins and almost coalesces with the first, is much feebler; the third, which is nearly one-third the height of the whorl from the summit, is more distinct and is separated from the second by a deep and wide channel; next the base of each whorl are three fine spiral striæ; others, to the number of four or five, occupy the space between the principal ridge and the summit; crossing these are very fine indistinct transverse arcuated wrinkles.

This shell is obviously distinct from the *variabilis* in the great inequality of the three principal ridges, the depth of the central channel, and the greater delicacy of the transverse wrinkles.

Locality, vicinity of Williamsburg; in the Miocene shell marl. Length, about two inches.

Turritella quadri-striata.

24. Shell turrited, regularly conical; whorls flattened, with four principal revolving equidistant spiral striæ; a fifth, less conspicuous, bounds the base of the whorl; the whole of these are alternated with five much smaller interposed striæ; near the summit of the whorls are traces of others yet more delicate; five transverse arcuated wrinkles, not very distinct.

Locality, Williamsburg, as before; length, one inch. This shell differs from the *variabilis* in the flatness of the whorls, and the number and relative proportion of the principal striæ; it is also a much more delicate and smaller shell.

Natica perspectiva.

25. Shell subglobose, smooth; substance of the shell rather thin; umbilicus open, with a rather prominent revolving rib, considerably above the middle of each volution, terminating at the labrum in a scarcely distinct callus; spire somewhat elevated and acute; aperture semicircular, five-eighths the length of the shell. Length, eight-tenths of an inch.

Locality, Williamsburg. Miocene. This shell resembles somewhat the *N. interna*, but it is obviously different in being less depressed, and in the form and proportions of the aperture; the general contour of the shell is also different.

Fissurella catilliformis.

26. Shell nearly elliptical, slightly subovate, depressed, conic, with approximate very regular longitudinal costæ, alternated with intervening striæ often very minute, the transverse concentric striæ giving a very uniform granulation to the costæ; foramen, oval, scarcely inclined; inner margin of aperture entire. Length, half an inch.

Locality, Shell banks, Prince George county. Miocene. This shell has some resemblance in its inner surface to the cavity of a dish.

Arca protracta.

27. Shell rather thick, very oblong transversely; ribs about forty, not very prominent, and hardly wider than the intercostal spaces, and longitudinally furrowed by three narrow grooves, the central one much the widest; a very indistinct granulation on the ribs, arising from the numerous minute transverse lines of growth crossing the longitudinal ridges of the ribs; beaks prominent and distant, opposite a point less than one-third the length of the hinge margin from the posterior extremity; area wide, with numerous distinct undulated grooves, parallel to the hinge margin; hinge margin rectilinear, with numerous minute straight teeth, those in the anterior half directed a little obliquely towards the anterior margin; posterior margin rounded slightly outwards, extending a little further backward than the angle; anterior margin much elongated, extending in an oval curve far in

advance of the end of the hinge; basal margin contracted opposite the middle of the hinge, and deeply crenate. Length, three and a half inches.

Locality, Shell banks, Prince George county. Miocene.

Lucina speciosa.

28. Shell sub-elliptical, inequilateral, inflated, rather thin, with equal close-set rather elevated longitudinal ribs, and regular very close concentric striæ; lunule small, very distinct, and ovate-lanceolate; beaks small, pointed, and slightly prominent beyond the general curve of the margin, placed about one-third the transverse length of the shell from the anterior end; cardinal teeth small, diverging; lateral teeth equal, distinct, and nearly equidistant from the anterior cardinal; hinge margin regularly arcuated, the rest of the margin, especially the posterior side, crenate within; posterior muscular impression elongated and slightly curved. Diameter, three-tenths; length, eleven-twentieths; height, nine-twentieths of an inch.

This very beautiful shell occurs in nearly all the localities of the Miocene in the James river region.

Venus cortinaria. Pl. 26

29. Shell sub-cordate, inflated, with very regular concentric, closely approximate, and very prominent imbricated ridges, which incline towards the beak, except the portion opposite the anterior, basal, and posterior margins, where they decline outwards towards the margin; beaks moderately prominent, about twice as far from the anterior as the posterior end; two anterior cardinal teeth, closely approximate above, second one of the left valve thick and sub-bifid; lunule wide, cordate; basal margin crenate within; posterior margin short, straight, and especially at the lunule finely crenate. Length, one inch; height, nine-tenths of an inch.

Locality, Williamsburg. Miocene. This beautiful shell rarely shows the concentric ridges perfect, from their prominence and thinness.

III. OF THE PLACE IN THE GEOLOGICAL SERIES TO WHICH THESE DEPOSITS BELONG.

30. That the strata here described, and the deposits identical and continuous with them, stretching extensively to the north and south into the adjoining states, are referable to the Miocene period of the American Tertiary, will be readily admitted on adverting to the well marked relations of their organic remains.

31. A careful summary of the fossils derived from the several localities hitherto examined within the peninsula, establishes the total number of those at present known to be very nearly one hundred. Of these not more than eighteen are ascertained to belong to species now living; showing a remarkable, though no doubt *accidental* coincidence with the average proportion of recent species found in deposits of the Miocene period in Europe.

Lest it may seem objectionable to institute the comparison between the recent and the extinct shells of several localities taken in the aggregate, the ratio has been examined as it exists in some of the localities separately. Thus in the cliffs at King's Mill on the James river, the whole number of species whose analogies are at present satisfactorily established, is about seventy-four, of which but fourteen are of the present day, or *recent.* The per-centage here disclosed is therefore about nineteen, being nearly the same with that above, and still almost identical with the proportions in several of the Miocene localities of Europe.

32. Making every possible allowance for future discoveries bringing to light as recent, some of the now supposed extinct species, it is still difficult to imagine, with such a ratio as we have at present, that the proportions can ever so far change as to make the living species of the deposit to equal or exceed the number of the extinct; a condition necessary of course to entitle it to the name of Older Pliocene, which it has received.

33. The circumstance that in Prince George county the Miocene is superimposed directly upon Eocene, from which it seems not to be separated by any features which would mark a long interval attended

by abrupt or violent actions, furnishes another, though not a decisive argument against its belonging to a period so late as the Older Pliocene. It seems reasonable to infer, that the two would hardly be seen resting together in exact conformability, as they do, had they been separated in time by the whole interval between the Eocene and the Older Pliocene, during which the surface of the former would be in a condition to undergo changes and irregularities nowhere perceived where they are seen in contact.*

IV. OF THE ORIGIN OF THE DEPOSIT OVERLYING THE MIOCENE SHELL MARL.

34. It is not easy, in the present state of our information, to approximate to the precise era when this overlying deposit was produced, though it appears to have had a date perhaps long anterior to the latest superficial diluvium with which it is often confounded. We infer this from the very general absence of all those signs which mark a trans-

* In a recent publication (Silliman's Journal, vol. 28, p. 106), Mr Conrad has attributed to a portion of the formation here under discussion, namely, the localities of Yorktown and the James river, near Smithfield, a date still more recent than the period of the Older Pliocene. He ranks those deposits, together with another at Suffolk, Virginia, and one on the St Mary's river, Maryland, under a new division, Medial Pliocene; it is stated at the same time that the recent species at those places compose about thirty per cent. A subdivision of the formation as it occurs in Maryland, characterized by Perna maxillata and a less proportion of recent species, is referred to the Older Pliocene, while the opinion is advanced that the Miocene is probably altogether wanting. Now to those familiar with the principles of the new nomenclature of the Tertiary, it is obvious that the beds, so styled, the Older as well as the Medial Pliocene, are entitled, in strictness, to the appellation of Miocene only.

To confer on a formation the name Medial Pliocene, its shells should contain about thirty per cent extinct, and seventy per cent recent, and not the *converse*. We believe, moreover, that the per-centage of recent species at Yorktown is even materially less than thirty.

In No. 3, of his work on American tertiary shells, issued a little earlier than the other article, Mr Conrad adopts a somewhat different classification, calling the several localities in Virginia and Maryland, Older Pliocene, as before, except that stratum low down in the Maryland formation which is distinguished by the Perna maxillata, and this he denominates Miocene. For reasons before stated, namely, the small per-centage of recent species throughout them *all*, we believe the whole together to have been produced in the Miocene epoch, and to belong to one formation; and we have been led into this note in the sincere wish to settle the question of the age of this division of our Atlantic Tertiary formations, lest the student of American geology be disheartened by the perplexity which grows out of a shifting and inconsistent nomenclature.

portation by violent causes from a distance, its materials being finely comminuted clays and sands usually arranged in a manner denoting a somewhat quiet deposition. On the other hand, its containing no fossils, its distinct separation from the fossiliferous marl stratum beneath it, the surface of which is furrowed and deeply channelled, as if an interval of erosive action had preceded it, are facts which may possibly displace it from the Miocene era altogether, and which, for the present at least, throw entire uncertainty upon the inquiry as to the position which it should occupy in the Tertiary series.

35. It is not unlikely, all things considered, that the origin of this deposit is to be traced in the rise from beneath the sea of some of the more western portions of the tide water plain; in other words, with the appearance above water of the Eocene tract in that quarter. This is rendered probable from the circumstance that this superficial bed often abounds near the *bottom* with grains of the green sand mineral so abundant in the Eocene of Virginia. It is corroborated, likewise, by the fact that the shelly Miocene stratum reposing upon the Eocene, sometimes shows tokens of considerable violence over its surface, the shells being, throughout a depth of several feet near the top, in a fragmentary state, and much disturbed, as may be seen in Prince George county, and on the Chickahominy river.

If we conceive that tracts in the Eocene district, or above it, were upheaved to near the water's level, or entirely out of it, while the country to the east was still submerged, we may not only explain the facts here mentioned, but by adverting to the nature of the actions which would supervene, we may account, by the sudden draining off of the uplifted water, for the eroded surface of the Miocene marl, and the sudden and total extinction of animal life which took place. To this would naturally succeed the introduction of nearly the same kind of matter under more tranquil circumstances, brought down from the newly exposed tract by river action, the probable source, we may conjecture, of some of the sands and clays of finer texture which occur so regularly and quietly stratified every where in the upper parts of the deposit.

Later than all these operations must have been the diluvial action, more or less extensive, which grooved the surface of this deposit throughout the Tertiary region with its innumerable ravines and shallow valleys of excavation. Whether this last change was impressed upon the surface by the final emergence of the whole territory from the sea to its present level, or by some more universal denuding flood which has swept the continent generally, we venture not to decide; though the comparatively small amount of transported superficial pebbles and boulders, and the absence of any which can be traced beyond the nearest rocks at the head of tide, incline us to attribute the denudation in question to the supposed *local* action rather than to the other.

V. EOCENE FORMATION OF VIRGINIA.

36. Though some attention has been devoted by Mr Conrad, and other American naturalists, to the Tertiary fossils of several localities in Virginia, as yet their researches have been limited to such as appertain to the subordinate divisions of the Tertiary group, arranged by Mr Lyell under the head of Pliocene and Miocene; and though the existence of an Eocene deposit might naturally have been inferred, no locality of this character appears to have been known to them. The existence of an extensive Eocene formation in eastern Virginia is now for the first time announced, as furnishing an interesting step in the progress of the geological inquiries which are now on foot by legislative authority in that state.

37. This formation appears to have a general meridional direction, traversing the state from the Potomac to the Roanoke. It is intersected and exposed by the principal rivers, first making its appearance at from twenty to thirty miles below the primary ridge. The most interesting locality which has as yet been visited, and that from which the fossils have been most abundantly obtained, is on the James river, beginning a little above City Point, and extending nearly in a continuous manner to Coggins Point, a distance, following the flexures of the shore, of about eleven miles. At Coggins Point, Torbay and Evergreen, the cliffs have a height varying from thirty to forty feet. At the base, a stratum of what appears at first to be a blackish clay extends nearly horizontally throughout the whole distance, rising a little as it ascends the river. Its height above the water at Coggins

Point is about three feet, at Evergreen upwards of ten, measured to the upper edge of the stratum. It continues downwards to a depth of six or eight feet, and terminates in an argillaceous clay of a bluish-gray colour. This dark stratum consists largely of particles of green sand, or silicate of iron and potash. It contains a great number of Eocene fossils, among which are Cardita planicosta, Fusus longævis, &c. &c. already known as existing either in the Eocene of Paris or Alabama, or in both. But besides these it also contains a variety of beautiful and new species, some of which will be described in the present paper. These shells are, at some points, almost entirely dissolved, and very perfect casts alone can be procured; but at other points, though in a soft condition, they can, by using great care, be obtained in an entire state.

38. Above this stratum is a layer of what Mr Edmund Ruffin, the able editor of the Farmer's Register of Virginia, calls gypseous earth. This stratum appears once to have abounded in fossils, but at present only casts, and those in a very soft condition, can be found. They are, however, identical with the fossils of the lower stratum. The earth of this layer, besides a considerable proportion of green sand, contains a large amount of sulphate of lime, disseminated in minute grains, and grouped in large and massive crystals. Immediately above occurs a thin stratum of white clay, at the junction of which with the former layer the crystallized gypsum is found in great abundance, and almost perfectly pure. Above the clay is a stratum of shells in a very disintegrated condition, but consisting of Ostrea sellæformis and other Eocene fossils, and immediately above is a stratum of the shells of our middle Tertiary. A few scattered pebbles of a brown hue, hardly numerous enough to form a stratum, separate these two very distinct formations. In this uppermost layer are found the common Pecten and Pectunculus of our middle Tertiary.* The whole thickness of the Eocene deposit

* Among the interesting fossils of the middle Tertiary above, is an enormous specimen of Astrea, which is worthy of being described. This mass was some years ago disengaged from the upper part of the cliff at Torbay, and is now lying on the shore, firmly fixed in the sand and clay. Though it has been much reduced in size since its fall, it is still of immense magnitude. Its form is of course very irregular, but its largest diameter may be estimated at four

at this point appears to be about twenty feet. At distant points, where this deposit has been examined, as for instance near the Piping Tree, on Pamunkey, and near Port Royal, on the Rappahannock, as well as upon the Potomac, much the same arrangement and succession of strata have been remarked.

39. The section at Coggins Point presents the interesting feature of a juxtaposition in the same cliff, of the Eocene and newer Tertiary formations, and on this account must be regarded as an important locality.

The fact too that in this as well as other places where the Eocene deposit has been discovered, so very large a proportion of the chloritic sand is contained in the matter embedding the fossils, is, we presume, an unexpected and interesting circumstance. Even the New Jersey secondary strata are seldom more abundant in this peculiar mineral product than the formation referred to, and hence the farmers of Virginia are beginning to apply this material to their fields.

VI. NEW FOSSIL SHELLS OF THE EOCENE OF VIRGINIA.

Nucula cultelliformis.

40. Shell ovate, ensiform, somewhat inflated, rounded before, much elongated, and tapering behind, the posterior length more than twice the anterior, furnished with very fine, hardly distinct concentric striæ, and one distinct and one very obscure rib behind; anterior part with an indistinct fold; shell thin; lunule long and lanceolate; beak small; anterior series of the teeth gently arched; posterior series straight; teeth in both acutely bent, the angles directed towards the beak; margin entire; cavity of shell shallow, with a ridge passing from the beak to the posterior margin. Transverse length, twenty-eight hundredths; height, eight hundredths of an inch.

Locality, Coggins Point, Prince George county, in the green sand stratum. This very delicate shell approaches nearest to the *N. media* of Lea, the Æqualis of Conrad, but differs in the great elongation of

and a half feet; and its weight is probably seven or eight hundred pounds. On the shore are likewise found vast numbers of the teeth of sharks, some of them of enormous dimensions.

the posterior end, in the ribs, and in the less distinctness of the transverse striæ.

Nucula parva.

41. Shell ovate, inflated, rounded before, not much produced, but rapidly tapering to a truncated point behind, furnished with about twelve rather coarse concentric folds or ridges, and a longitudinal gently depressed groove or undulation of surface, running from near the beak to the posterior basal margin; beaks nearly central; anterior series of teeth slightly arched; posterior series nearly straight; margin entire; cavity rather deep. Length, three-twentieths; height, two-twentieths of an inch.

Locality, same as the preceding.

Ostrea sinuosa.

42. Shell sub-orbicular, or equilaterally sub-triangular; inferior valve moderately convex, with the laminæ of growth profoundly plicated into loops, which are imbricated so as to produce regularly radiating ribs; hinge-plane depressed, and in a line with the dorsal margin, which is long and straight, the sides of the inferior valve being dilated into the form of ears; fosset placed symmetrically and centrally in the hinge, and less than one-third its length, and curving suddenly at its termination in a narrow groove; beak slightly curved to the right and truncate; muscular impression small; inferior valve very slightly convex or flat, nearly circular, with concentric almost circular wrinkles. Length of the specimen four and a half inches; diameter between the ears five and a half inches; diameter of flat valve four inches.

Locality, Evergreen, James river, in the lower or green sand stratum of the Eocene. This very beautiful fossil oyster will be seen to differ from the *O. compressirostra* in several essential particulars, especially in the structure of the hinge, in the more symmetrical and profound plications on the inferior valve, in its less convexity, and in its more regular dilatation on the upper margin into partial ears.

Cytherea ovata.

43. Shell subovate, somewhat inflated, with concentric transverse

striæ, very fine near the umbones, but much coarser near the margin; beaks rather elevated; lunule very indistinct; teeth elevated and straight, the two posterior ones of the left valve small, much compressed, approximate, and nearly parallel; the anterior tooth large and grooved by a deep canal; cavity of shell deep; margin entire; posterior margin straight, and separated from the muscular impression by a fold or groove. Length, one inch and one-tenth; height eighty-five hundredths of an inch.

Locality, Coggins Point, in the Eocene green sand.

ARTICLE XV.

On the Difference of Longitude of several places in the United States, as determined by observations of the Solar Eclipse of November 30th, 1834. By Edward H. Courtenay, Professor of Mathematics in the University of Pennsylvania. Read October 16th, 1835.

The interest felt by the American Philosophical Society in relation to the late remarkable Solar Eclipse, as expressed by the appointment of a committee to collect accurate observations thereon, has induced the belief that a careful calculation of some of the principal results furnished by those observations, might prove acceptable to the Society.

From the report of the committee above referred to, it appears that observations of the times of commencement and termination of the eclipse were made at Philadelphia, Baltimore, Norfolk, the University of Virginia, Cincinnati, the Friends' School near Philadelphia, Germantown, and at West Hills, Long Island, a station of the coast survey. The termination was also observed at Nashville, Tennessee. Many of these observations were made by persons whose well known skill and experience are a sufficient guarantee of the accuracy of their results; and they *all* appear to have been made with great care.

The most useful purpose to which observations of this kind are applicable, is the determination of the difference of terrestrial longitude; and although the method is doubtless inferior in point of accuracy to that of occultations, and probably to that of corresponding transits of the moon and stars, yet the results which it furnishes, when obtained under favourable circumstances, may always be considered as near approximations to the truth, and are particularly valuable in a country like our own, whose geography must yet be regarded as very imperfect.

The difference in the results obtained by the several observers in Philadelphia, confirms the opinion, now generally entertained, that the times of commencement and termination of a solar eclipse cannot be observed with a very high degree of precision; and the same inference is deducible from a comparison of the durations of the eclipse at the several places of observation. In every case where the commencement and end have both been observed, the duration indicated the necessity of a reduction in the sum of the semi-diameters of the sun and moon, similar to that usually made for irradiation and inflexion, but the amount of this correction, as determined by the observations at different places, varies from 1″.5 to 4″.5. These discrepances are undoubtedly attributable, in a great measure, to the extreme difficulty of fixing with precision the instants at which the eclipse begins and terminates.

In determining the times of conjunction of the sun and moon, the correction for irradiation and inflexion has been assumed at 3″.3, that being the mean result furnished by all the observations which have been calculated. To ascertain the amount of this correction from the observations at each place, the observed duration was compared with that which would have occurred had such correction been unnecessary; likewise with the duration due to an irradiation and inflexion of 5″. Then, by a simple proportion, the value of the correction was estimated.

The parallaxes in latitude and longitude were calculated by the method of the nonagesimal, and the deduced terrestrial longitude was found in every case to agree so nearly with that assumed, as to render a repetition of the calculation unnecessary. The errors in the Lunar Tables, being very nearly eliminated by the comparison of observations at different places, have been neglected.

Having adopted a mean value for the correction for irradiation and inflexion, the times of conjunction of the sun and moon, as deduced from the commencement and termination at each place, are found to differ slightly from each other. Both these times are inserted in the first of the annexed tables, in order that an opinion may be formed as to the accuracy of the observations. It will be seen that in no case does the time of conjunction deduced from the beginning or end differ from the mean of the two results by a quantity greater than 3″.14. In the second table are given the results obtained by neglecting the correction for irradiation and inflexion. The contents of these tables will be readily understood without further explanation.

In calculating the time of conjunction for Philadelphia, I have employed the data furnished by my own observations, but as they are perhaps less worthy of confidence than those obtained by other observers in the city, it is proper to remark that a mean of all the results furnished by the committee appointed to collect observations makes the time of commencement at Philadelphia (State House), 1 h. 0 m. 15.1 s., and that of termination 3 h. 37 m. 49.5 s.

The longitude of the State House, west of Greenwich, was assume equal to 5 h. 0 m. 43.7 s., in estimating the positions of the several places with reference to this latter meridian.

At most of the stations where observations were made, the weather is described as having been decidedly favourable; and although the instrumental means at the disposal of the several observers were probably of very different powers, yet the observations, almost without exception, are represented to have been satisfactory. At Philadelphia, the time of commencement may probably be relied on with more certainty than that of termination, as the latter was rendered somewhat uncertain by the interposition of thin fleecy clouds.

The longitude of the several places (with the single exception of Cincinnati), as deduced from these observations, will be found to differ but slightly from those given in the American Almanac, as the results of the best observations previously made.

In conclusion, it is proper to remark that I have been prevented from calculating all the observations furnished to the Society, only by the want of sufficient leisure; and that those omitted have not been neglected from any doubt as to their accuracy.

Elements employed in Calculating the Difference of Longitude, from Observations of the Solar Eclipse of Nov. 30th, 1834.

Place of Observation.	Latitude.	Commencement.	End.	Mean time at the respective places.
		h. m. s.	h. m. s.	
Philadelphia, University of Pennsyl.	39° 57′ 01″	1 00 09.1	3 37 50.1	
University of Virginia.	38 02 03	0 41 11.0	3 23 43	
Cincinnati Female Academy.	39 06 00	0 03 39.71	2 49 39.71	
Baltimore, 1 mile west of Battle Mon.	39 17 12	0 51 58	3 31 29.5	
West Hills, Long Island.	40 48 47.1	1 09 53.44	3 45 18.55	
Norfolk, Virginia.	36 51 10	0 55 54.6	3 37 02.1	
University of Nashville.	36 09 32.7	not observed.	2 41 45.2	

Results obtained by assuming Irradiation and Inflexion = 3″.3.

Place of Observation.	Time of Conj. from obs. of com.	Time of Conj. from obs. of end.	Mean of Times of Conjunction.	Difference of Longitude.	Longitude from Greenw.
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Philad. reduced to State House.	1 47 05.87	1 47 05.35	1 47 05.61	0 00 00.00 W.	5 00 43.90
University of Virginia.	1 33 42.04	1 33 47.21	1 33 44.62	13 20.99 W.	5 14 04.89
Cincinnati Female Academy.	1 09 38.60	1 09 38.07	1 09 38.33	37 27.28 W.	5 38 11.18
Balt. reduced to Battle Monu.	1 41 25 79	1 41 22.54	1 41 24.16	5 41.45 W.	5 06 25.35
West Hills, Long Island.	1 54 02.12	1 54 04.96	1 54 03.54	6 57.93 E.	4 53 45.97
Norfolk, Virginia.	1 42 41.71	1 42 37.29	1 42 39.50	4 26.11 W.	5 05 10.01
University of Nashville.	com. not obs.	1 00 44.36	1 00 44.36	46 20.99 W.	5 47 04.89

Results obtained by neglecting Irradiation and Inflexion.

Place of Observation.	Time of Conj. from ob. of com.	Time of Conj. from ob. of end.	Mean of Times of Conjunction.	Difference of Longitude.	Longitude from Greenw.	Ir. & In. from du.
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	
Philadelphia, State House.	1 47 11.64	1 46 59.49	1 47 05.56	0 00 00.00 W.	5 00 43.90	3″.5
University of Virginia.	1 33 47.83	1 33 41.37	1 33 44.60	0 13 20.96 W.	5 14 04.86	1 .5
Cincinnati Female Acad.	1 09 44.40	1 09 32.18	1 09 38.29	37 27.27 W.	5 38 11.17	3 .5
Balt. Battle Monument.	1 41 31.56	1 41 16.69	1 41 24.12	5 41.44 W.	5 06 25.34	4 .2
West Hills, Long Island.	1 54 07.90	1 53 59.09	1 53 03.49	6 57.93 E.	4 53 45.97	2 .5
Norfolk, Virginia.	1 42 47.48	1 42 31.47	1 42 39.47	4 26.09 W.	5 05 09.99	4 .6
University of Nashville.		1 00 38.47	1 00 38.47	46 21.02 W.	5 47 04.92	

By comparing the results furnished by these two tables it will be seen that although the times of conjunction deduced either from the commencement or end, when the correction for irradiation and inflexion is applied, differs considerably from that obtained when this correction is neglected, yet the mean of the times of conjunction in the former case differs almost imperceptibly from that in the latter, and the differences of longitude resulting from the two methods of calculation are almost identical.

ARTICLE XVI.

Observations on Sulphurous Ether, and Sulphate of Etherine (the true Sulphurous Ether). By R. Hare, M. D., Professor of Chemistry in the University of Pennsylvania.

It is known that when two parts, by weight, of sulphuric acid are distilled with one of alcohol, a yellow sulphurous liquid is obtained. Berzelius alleges, that when this liquid is exposed in an exhausted receiver over sulphuric acid and hydrate of potash, an oleaginous liquid remains, which he designates as "*oil of wine containing sulphuric acid, or heavy oil of wine.*"

This oil is, by the same author, described as being heavier than water, as having a penetrating aromatic odour, and a cool pungent taste, resembling that of peppermint. It is, in fact, the liquid which Hennel first analysed as oil of wine, without, at the same time, mentioning the process by which it was procured. No doubt the difference between it and that procured by Boullay and Dumas, was, in some degree, the cause of the discordance between his observation and theirs. According to Hennel, the oil of wine consists of an atom of sulphuric acid, and an atom of hydrocarbon: $\dddot{S} + 4C + 4H$. By the last mentioned appellation, this skilful chemist designates a compound consisting of four atoms of carbon, and four of hydrogen.

Serullas represents the oil in question as consisting of two atoms of the acid, two of hydrocarbon or etherine, and one of water.

To the hydrocarbon of Hennel (4 C H), as the common base of all the ethers, excepting those lately alleged to have mytheline for a base; the name of etherine has been given; so that the heavy oil of wine may be called the sulphate of etherine: or, according to the formula of Serullas, $2\ddot{S}E + H$, it is a hydrous sulphate of etherine. It is, in fact, the only compound to which the name of sulphuric ether can be applied with propriety. The yellow liquid out of which it is procured, as above stated, may be designated as the ethereal sulphurous sulphate of etherine.

Another oil, lighter than water, resulting from the distillation of the ethereal sulphurous sulphate of etherine, from hydrate of lime, or from potash, is described by Berzelius as oil of wine exempt from sulphuric acid. Of this the odour is represented as disagreeable; and, though nothing is said of its taste, it is to be presumed that it differs from the heavy oil of wine in this respect, as well as in its odour and specific gravity.

Thènard alleges, that when the heavy oil of wine is heated with water for some time, a liquid swims on the water, which, if refrigerated by ice, will, within twenty-four hours, deposit crystals. The mother liquid he calls light oil of wine, while to the crystals he gives the name of concrete oil of wine. Hennel mentions his having obtained a similar product by the reaction of oil of wine with water, or an aqueous solution of potash; and treats the crystalline matter as the base of the heavy oil of wine, deprived of its acid; or, in other words, as his "hydrocarbon;" or, as above mentioned, etherine.

Considering how much has been written on this topic, I am surprised that I have met with no statements respecting the reaction of ammonia with the above mentioned ethereal sulphurous sulphate of etherine.

Since the year 1818, I have been accustomed to saturate the acid in that liquid by ammonia. The residue, being rendered very fragrant, and entirely freed from its sulphurous odour, by admixture with about twenty-four parts of alcohol, was found to constitute an anodyne, possessing eminently all the efficacy of that so long distinguished by the name of Hoffman. When the residue, remaining after saturation with ammonia, was distilled in a water bath, ether came over, and left an oil which I was accustomed to consider as the oil of wine.

I had observed that, in the process above mentioned, there was a striking evolution of vapour, which seemed irreconcilable with the received opinion of the re-agents employed. Since the affinity between the ammonia and sulphurous acid is energetic, it did not appear to be reasonable that a copious escape of the one should be caused by its admixture with the other; and it was no less improbable that the vaporization of hydric ether, in its natural state, could take place at temperatures so much below its boiling point as those at which this phenomenon was noticed. In order to ascertain the truth, I luted a funnel, furnished with a glass cock and an air tight stopple, into the tubulure of a retort, of which the beak was so recurved downwards as to enter and be luted into the tubulure of another retort. The beak of the latter passed under a bell over water.

Both retorts were about half full of liquid ammonia, and surrounded with ice. The apparatus being thus arranged, about a thousand grains of the ethereal sulphurous sulphate of etherine were poured into the funnel, and thence gradually allowed to descend into the ammonia in the first retort. Notwithstanding the refrigeration, much heat was perceptible, and a copious evolution of vapour, which, passing into the second retort, was there absorbed or condensed, none being observed to reach the bell glass. At the close of the operation, hydric ether, holding oil of wine in solution, floated upon the ammonia in the first retort, and pure ether, of the same kind, floated on the ammonia in the second.

The ammonia in both retorts gave indications of the presence of sulphurous acid, on the addition of sulphuric acid. From these results, I inferred that a chemical compound of sulphurous acid and hydric ether formed the principal portion of the yellow liquid, and might be separated by distillation. Accordingly, by means of retorts arranged and refrigerated as above described, I procured a portion of sulphurous ether, which boiled at 44°, and which, when agitated with ammonia in a bottle, produced so much heat and consequent vapour, as to expel the whole contents in opposition to the pressure of my thumb. By employing the same distillatory apparatus, I subjected 2150 grains of the ethereal sulphurous sulphate of etherine to distillation, and obtained 726 grains of sulphurous ether, which boiled as soon as the frigorific mixture was removed from the containing retort. This being redistilled, as in a former experiment, so as to receive the product in ammonia, left in the retort five grains of oil of wine. The resulting ammoniacal liquid, saturated with chloride of barium in solution, gave a precipitate which, agreeably to the table of equivalents, contained 356 grains of sulphurous acid.

The residue of the 2150 grains of ethereal sulphate being subjected to distillation, raising the temperature from 95°, the point at which it had been before discontinued, to 140°, the product obtained by means of a refrigerated receiver weighed 602 grains. This was, of course, inferior in volatility to the first portion distilled; and, when redistilled, it was found to contain a small quantity of oil of wine. In fact, it appears, the boiling point of the ethereal sulphurous sulphate rises, not only as the ratio of the sulphurous acid lessens, but also as the proportion of oil of wine augments.

The residual liquid being exposed to the heat of a water bath at 212°; a very fragrant, and well flavoured oil of wine was evolved, and floated upon a quantity of water acidulated by sulphuric or sulphovinic acid.

Agreeably to another experiment, 1750 grains by weight, of the ethereal sulphurous sulphate of etherine, after washing with ammonia, gave 869 grains of an ethereal solution of oil of wine. This being subjected to distillation by a water bath raised gradually to 190°, there remained in the retort 148 grains of oil, beneath which there were a few drops of acidulated water. Agreeably to the result of several experiments, the ethereal sulphurous sulphate of etherine yields about half its weight of the ethereal solution of oil of wine. The quantity is always somewhat less than half when weighed; but the deviation is not greater than might be expected to result from the loss by evaporation, and the diversity of refrigeration employed in the condensation of the ethereal sulphurous sulphate, during the process by which it is evolved.

Under the expectation of procuring a sulphurous ether of a still higher degree of volatility, I associated with the apparatus usually employed in the process for generating hydric ether, a series of tubulated retorts, of which the beaks were recurved downwards in such a manner that the beak of the first communicated with a perpendicular tube, passing through an open-necked cylindrical receiver, so as to enter the tubulure of the second retort, of which the beak was in like manner inserted into a tube passing through a receiver in a third retort, and this communicated in like manner with a fourth retort. The second, third and fourth retorts, and the tubes entering them, were all refrigerated, the first with ice, the second with ice and salt, and the third with ice and chloride of calcium.

By these means, on subjecting to distillation in the first retort 48 ounces of alcohol of 830, and a like weight of sulphuric acid, besides the ethereal sulphurous sulphate of etherine usually resulting from the process, and condensing in the first receiver, it was found that in the other retorts severally, there were liquids of various degrees of volatility. That in the last boiled at 28°, but the boiling points rose gradually as the quantity of the residual liquid diminished.

In order to ascertain the nature of the sulph-acids abstracted from the ethereal sulphurous sulphate of etherine by the ammonia employed, chloride of barium was added in excess to the resulting ammoniacal solution, until no further precipitate would ensue. The liquid having been rendered quite clear by filtration, soon became milky. By evaporation to dryness, and exposure to a red heat, a residuum was obtained which proved partially insoluble in chlorohydric acid, and by ignition with charcoal, yielded sulphide of barium. It appears, therefore, that a hyposulphate of barytes existed in the liquid after it was filtered; as I believe that the hyposulphuric acid is the only oxacid of sulphur which is capable of forming with barytes a *soluble* compound, susceptible, by access of oxygen, of being converted into an insoluble sulphate, and precipitating in consequence.

It must be evident from the facts which I have narrated, that the yellow liquid obtained by distilling equal measures of sulphuric acid and alcohol, consists of oil of wine held in solution by sulphurous ether, composed of nearly equal volumes or weights of its ingredients; also, that the affinity between the *ether* and the acid is analogous to that which exists between alcohol and water. The apparent detection of sulphuric acid in the ammonia, justifies a surmise, that the etherine distils in the state of a hyposulphate, which subsequently undergoes a decomposition into sulphurous acid and sulphate of etherine.

The liquid above alluded to, as resulting from the saturation of the ethereal sulphurous sulphate of etherine by ammonia, and distillation by means of a water bath gradually raised to a boiling heat, is a very fragrant variety of oil of wine. It differs from that described by Berzelius as the heavy oil of wine of Hennel and Serullas, in being lighter and containing less sulphuric acid. I have a specimen exactly of the specific gravity of water, and have had one so light as to float on that liquid. The oil of wine obtained by ammonia approximates, in its qualities, to the variety which Thènard describes as light oil of wine. The presence of sulphuric acid in a definite or invariable ratio does not appear requisite to the distinctive flavour or odour of oil of wine.

The heavy oil of wine treated by Hennel as sulphate of hydrocarbon, $2\dddot{S} + 4\,CH$; and by Serullas as a hydrous sulphate of etherine, $4\,CH + 2\dddot{S} + \dot{H}$; I have obtained, as above mentioned, by exposing the ethereal sulphurous sulphate of etherine, in vacuo, over the hydrate of lime, or potash, and sulphuric acid. This variety sinks in water, being of the specific gravity of 1.09 nearly; is of a deeper hue than the other, and of a smell less active, with a taste somewhat more rank. A specimen of oil thus obtained being subjected to the distillatory process, a portion came over undecomposed, leaving in the retort a carbonaceous mass. 14 grains of the oil which had not undergone distillation, and a like portion of the distilled oil, were severally boiled in glass tubes with nitric acid until red fumes ceased to appear; about 28 grains of pure nitre were added to each, some time before the boiling was discontinued. The resulting liquid was in each case poured into a platina dish, boiled dry, and afterwards deflagrated by a red heat. The residual mass being subjected to water, the resulting solution was filtered, an excess of nitric acid added, and then nitrate of barytes in excess.

The precipitate obtained from the distilled oil, weighed, when dry, only nine and five-eighths grains, while that procured from the oil which had not been distilled, amounted, under like circumstances, to fourteen and one-eighth grains. Ten grains of another portion, left for some time over liquid ammonia, yielded only seven-eighths of a grain of sulphate.

About a drachm of Hennel's oil of wine was subjected to distillation with strong liquid ammonia; fourteen and a half grains came over, retaining the appropriate fragrance and flavour. This yielded, by the process above described, only two grains of sulphate of barytes. After all the water and ammonia had distilled, the receiver was changed, and fourteen grains of oil, devoid of the fragrance and flavour of the oil of wine, were obtained. This yielded one and one-eighth grains of sulphate. A carbonaceous mass, replete with sulphuric acid, remained in the retort.

Hennel states that when oil of wine was heated in a solution of potash, an oil was liberated which floated upon water, having but little fluidity when cold; and which, in some cases, partially crystallized. When gently heated, it became clear, and of an amber colour. The vapour had an agreeable, pungent, aromatic smell. This oil must have been pure etherine.

It is not improbable that this oil, which may be considered as devoid of sulphuric acid, is more or less liberated in evolving oil of wine, according to the nature of the process employed; and that the oil alluded to by Thènard, and those procured by me by simple distillation, ebullition, or distillation with ammonia or potassium, are mixtures of the etherine with its sulphate in various proportions. As it is well known that the odour of the essential oils is rendered more active by dilution, the livelier smell of the solutions may be consistent with a diminished proportion of the odoriferous matter.

Oil of wine cannot be distilled per se without partial decomposition, which does not take place below the temperature of 300. When subjected to the distillatory process, over potassium, at a certain temperature, a brisk reaction ensued, and the oil and metal agglutinated into a gelatinous mass. By raising the temperature the mass liquefied, and a colourless oil came over, which retained the odour of oil of wine. Meanwhile some of the potassium remained unchanged, and appeared within the liquid in the form of pure metallic globules. On pouring into the retort a portion of nitric acid in order to remove the caput mortuum, ignition took place from the presence of the potassium.

ARTICLE XVII.

Of the Reaction of the Essential Oils with Sulphurous Acid, as evolved in union with Ether in the process of Etherification, or otherwise. By R. Hare, M. D., &c., &c., &c.

HAVING mixed and subjected to distillation two ounces of oil of turpentine, four ounces of alcohol and eight ounces of sulphuric acid, a yellow liquid came over, having all the appearance of that which is obtained in the process for making oil of wine, described in the preceding article. On removing, by means of ammonia, the sulphurous acid existing in the liquid, and driving off the ether by heat, a liquid remained, which differed from oil of turpentine in taste and smell, although a resemblance might still be traced. This liquid was without any sensible action on potassium, which continued bright in it for many weeks. It proved, on examination, to contain a small quantity of sulphuric acid. I ascertained, afterwards, that in order to produce these results, it was sufficient to pour oil of turpentine on the mass which remains after the termination of the ordinary operation for obtaining ether, and apply heat. Subsequently it was observed that when the sulphurous ether was removed by heat or evaporation, without the use of the ammonia, the proportion of sulphuric acid in the remaining oil was much greater.

By subjecting to the same process several essential oils, I succeeded in obtaining as many liquids to which the above remarks were equally applicable. With some of the oils, however, similar results were, by this method, either totally or partially unattainable, in consequence of their reaction with the sulphuric acid being so energetic as to cause their decomposition before any distillation could take place. No product can be obtained by distillation with sulphuric acid and alcohol from the oil of cinnamon obtained from cassia. From the oils of sassafras and cloves, but little can be procured.

However, in one instance, by previously mixing the oil of sassafras with the alcohol, in the manner described in the account given of the first experiment with the oil of turpentine, I succeeded in obtaining, in addition to a small quantity of the heavy liquid containing sulphuric acid, a minute quantity of a lighter one, devoid of that acid, which burned without smoke, was insoluble in water, and very fluid. I am disposed to consider the liquid thus procured as a hydrate of sassafras oil, or sassafreine, as I would call it, being analogous to hydric ether.

The oil of sassafras, whether isolated or in combination, possesses a remarkable property, which, I believe, has not attracted sufficient observation: I mean that of producing an intense crimson colour, when added, even in a very minute quantity, to concentrated sulphuric acid.

One drop of oil of sassafras imparted a striking colour to forty-eight ounce measures of sulphuric acid, and appeared perceptible when it formed less than a five millionth part. This property was completely retained by the lighter liquid above described as procured from oil of sassafras.

I subsequently observed, that when sulphurous acid, whether in the form of sulphurous ether, in that of a gas, or when in union with water, was brought into contact with any of the essential oils (including kreosote), which were subjected to the experiment, they acquired a yellow colour, and a strong smell of this acid.

In the case of the yellow compound thus obtained from any of the essential oils which I have tried, if the sulphurous acid be removed by heat, the oil, by analysis, will be found to yield sulphuric acid. That some acid of sulphur remains in union must be evident, since washing with ammonia will not entirely remove the power of yielding sulphuric acid; and the total absence of the sulphurous smell demonstrates that the sulphurous acid either enters into an intimate combination with the oil, or acquires oxygen sufficient to convert it into sulphuric or hyposulphuric acid.

Those essential oils which contain oxygen, are most affected by the action of sulphurous acid.

Both the oils of cloves and cinnamon, after admixture with sulphurous ether and subsequent distillation, gave, on analysis, precipitates of sulphate of barytes. In the case of cloves, the precipitate amounted to one-seventh of the whole weight.

By distilling camphor with alcohol and sulphuric acid, I obtained a yellow liquid, which, by washing with ammonia and evaporation, in order to get rid of the sulphurous ether, yielded an oil. The oil, by standing, separated into two portions, one solid, the other liquid. The solid portion resembled camphor somewhat, in smell, but differed from it by melting at a much lower temperature, becoming completely fluid at 175°.

I found that the essential oils of cinnamon and cloves possessed an antiseptic power, quite equal to that of kreosote, and that their aqueous solutions, when sulphated, were even superior to similar solutions of that agent.

One part of milk mingled with four parts of a saturated aqueous solution of the sulphated oil of cloves, remained after five days sweet and liquid, while another portion of the same milk became curdled and sour within twenty-four hours. Having on the 2d day of July added two drops of oil of cinnamon to an ounce measure of fresh milk, it remained liquid on the 11th; and, though it finally coagulated, it continued free from bad taste or smell till September, although other portions of the same milk had become putrid. A half ounce of milk, to which a drop of sulphurous oil of turpentine had been added, remained free from coagulation at the end of two days, while another portion, containing five drops of pure oil of turpentine, became curdled and sour on the next day.

A number of pieces of meat were exposed in small wine glasses, with water impregnated with solutions of the various essential oils. Their antiseptic power seemed to be in the ratio of their acridity. The milder oils seemed to have comparatively little antiseptic power, unless associated with the sulphurous acid, which has long been known as an antiseptic.

In cutaneous diseases, and, perhaps, in the case of some ulcers, the employment of the sulphurous sulphated oils may be advantageous.

A respectable physician was of opinion that the sulphurous sulphate of turpentine had a beneficial influence in the case of an obstinate tetter.

Possibly the presence of sulphurous acid may increase the power of oil of turpentine as an anthelmintic.

Pieces of corned meat hung up, after being bathed with an alcoholic solution of the sulphurous sulphated oil of turpentine, or with solutions of the sulphated oils of cloves or cinnamon, remained free from putridity at the end of several months. That imbued with cinnamon had a slight odour and taste of the oil.

I am led, therefore, to the impression that the antiseptic power is not peculiar to kreosote, but belongs to other acrid oils and principles, and especially to the oils of cinnamon and cloves.

The union of sulphuric acid with these oils appears to render them more soluble in water: whether any important change is effected in their medical qualities by the presence of the acid may be a question worthy of attention.

I have stated my reasons for considering the ammoniacal liquid, resulting from the ablution of the ethereal sulphurous sulphate of etherine with ammonia, as partially composed of hyposulphuric acid. By adding to this ammoniacal liquid a quantity of sulphuric acid, sufficient to produce a strong odour of sulphurous acid, and then a portion of any of the essential oils; a combination ensued, as already described, between the oils and the sulphurous acid liberated by the sulphuric acid, so as to render them yellow and suffocating. The habitudes of cinnamon oil from cassia under these circumstances were peculiar. A quantity of it was dissolved, communicating to the liquid a reddish hue. The solution being evaporated, a gummy translucent reddish mass was obtained, which, by solution in alcohol, precipitated a quantity of salt, and being boiled nearly to dryness, re-dissolved in water, and again evaporated, was resolved into a mass having the friability, consistency and translucency of common rosin; but with a higher and more lively reddish colour. Its odour recalls, but faintly, that of cinnamon; its taste is bitter and disagreeable, yet recalling that of the oil from which it is derived. Its aqueous solution does not redden litmus; nor, when acidulated with nitric acid, does it yield a precipitate with nitrate of barytes.

Of this substance ten grains were exposed to the process above mentioned, for the detection of sulphuric acid, and were found to yield a precipitate of 6.5 grains of sulphate of barytes.

It may be worth while to mention, that in boiling the sulphated oils with nitric acid, compounds are formed finally, which resist the further action of the acid, and are only to be decomposed by the assistance of a nitrate and deflagration. I conjecture that these compounds will be found to merit classification as ethers formed by an oxacid of nitrogen.

One of my pupils, in examining one of the compounds thus generated, was, as he conceived, seriously affected by it, suffering next day as from an over dose of opium. He also conceived that a cat, to which a small quantity was given, was affected in like manner.

I had prepared an apparatus with the view of analyzing accurately the various compounds above described or alluded to, by burning them in oxygen gas; when, by an enduring illness of my assistant, and subsequently my own indisposition, I was prevented from executing my intentions.

ARTICLE XVIII.

Of Sassarubrin, a Resin evolved by Sulphuric Acid from Oil of Sassafras, which is remarkable for its efficacy in Reddening that Acid in its concentrated state. By R. Hare, M. D., &c., &c., &c.

This colour is due to a peculiar resin, which I would call sassarubrin, being elaborated from the oil of sassafras, by its reaction with sulphuric acid, with phenomena which are striking, and, in some respects, singular. If a mixture be made of equal parts of the oil of sassafras, alcohol and sulphuric acid, on raising the temperature to a certain point, the whole mass rises up in a resinous foam, of a beautiful colour, between copper and purple, with a metallic brilliancy. In some instances, it has been partially forced out of the retort through the beak in a cylindrical mass, which acquired, on cooling, the consistency of pitch. This pitchy substance is a compound of the resin above alluded to and sulphuric acid, with which it forms a soluble substance, neutralising its sourness to a certain extent. By steeping this subacid compound in ammonia, straining, washing the residue with water, and desiccation, a brittle tasteless resin remains, which is quite insoluble in water, but very soluble in alcohol and hydric ether.

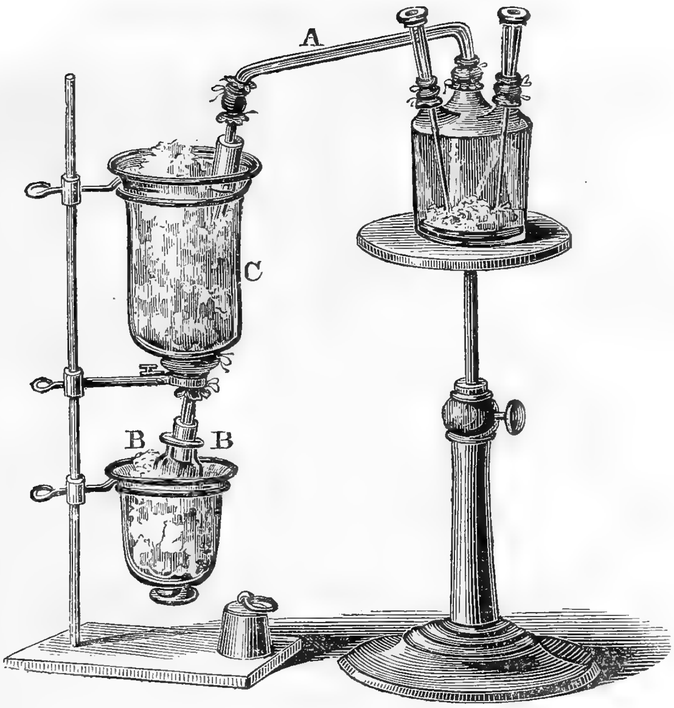
The addition of this sassarubrin to concentrated sulphuric acid, produces the crimson colour already mentioned as resulting from the presence in that liquid of a minute portion of oil of sassafras. I infer that the colour is due to the evolution of sassarubrin, which has a bassic affinity for the acid, to which it owes its birth. The ethereal and alcoholic solutions of sassarubrin are of the colour of a dingy white wine, but acquire a deep crimson when mingled with concentrated sulphuric acid.

Sassarubrin may be produced by the union of the acid and oil, provided it be moderated by refrigeration or dilution with water.

Without some precaution, the heat produced is sufficient to char the resin more or less. The reddening influence of the oils of cinnamon and cloves is due to the generation of resins analogous to sassarubrin.

To those resins the names of cinnarubrin and clovorubrin may be severally assigned. Cinnarubrin may be evolved by adding oil of cinnamon to equal parts of sulphuric acid and water, previously mixed and refrigerated, the temperature being subsequently elevated till the mass rises up in a foam; when the whole should be poured into a solution of pearlash, from which the resin may be extricated by a strainer. It is analogous to sassarubrin, but is less efficacious in colouring sulphuric acid, and does not, like the former, impart to the sides of the containing glass a rich red colour. Moreover, it appears to be partially insoluble in alcohol, and to retain sulphuric acid after being boiled with an alkaline solution.

I infer that a new series of resins may be evolved from the essential oils by their reaction with sulphuric acid; which, having a general analogy to each other, may still have discriminating characteristics, arising from the oils whence they may be derived.



ARTICLE XIX.

Process for Nitric Ether, or Sweet Spirits of Nitre, by means of an approved Apparatus. By R. Hare, M. D., &c., &c., &c.

The reaction of nitric acid with alcohol is so difficult to regulate, in the ordinary mode of making nitric ether in which the whole of the materials are mingled at the outset of the process, that I was induced, about twelve or fifteen years ago, to introduce an apparatus in which they were gradually added together within a glass bottle, by means of glass funnels with glass cocks.

Subsequently I adopted the more simple apparatus represented in the accompanying figure.

Providing a bottle with three tubulures, let one tubulure communicate, by means of a recurved tube A, with another tube passing perpendicularly through an open-necked inverted receiver C, and entering a bottle surrounded with ice and salt, occupying a suitable vessel **B B.** The cavity of the receiver should likewise be occupied by a freezing mixture.

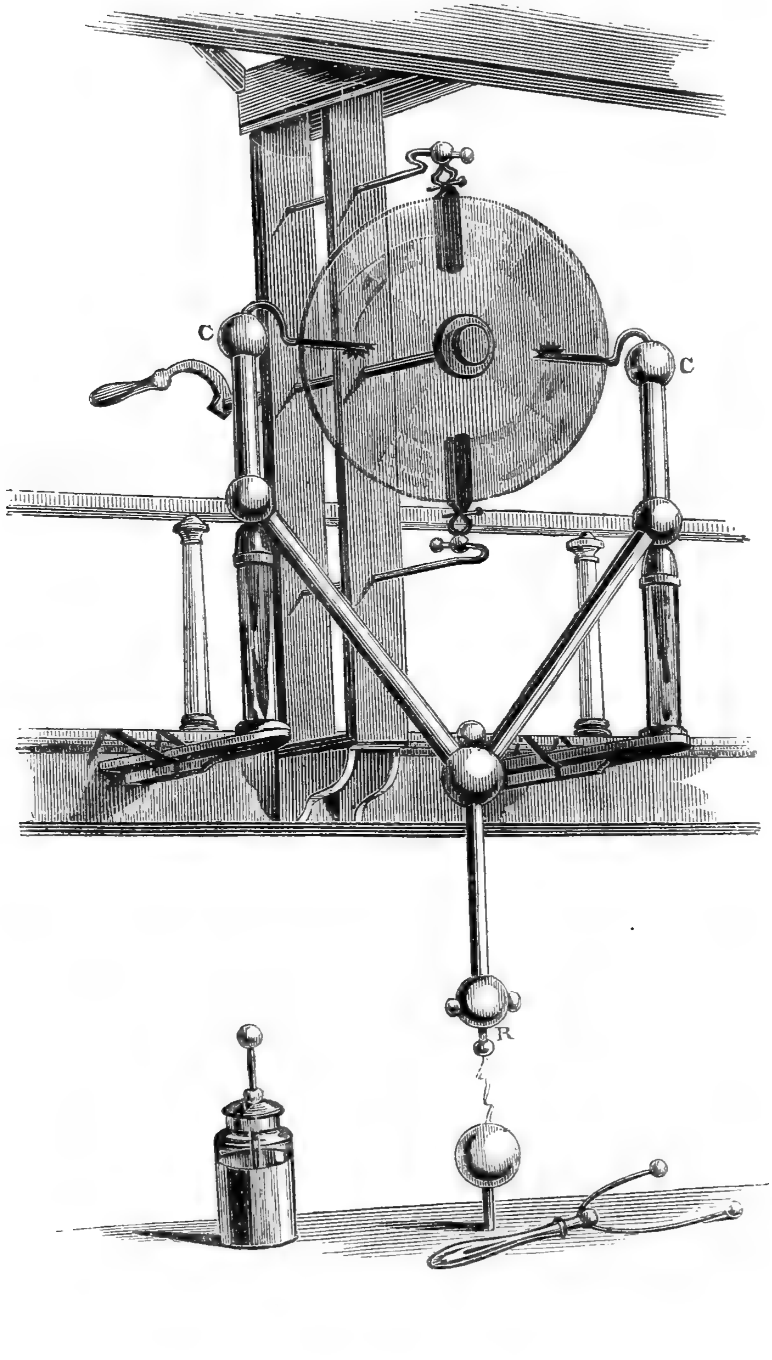
Into each of the remaining tubulures let a glass tube be introduced, ground or luted to fit air tight, and tapering so as to terminate in a capillary orifice near the bottom of the bottle.

Through one of the tubes introduce as much alcohol as will cover the bottom of the bottle, and then, by means of the other tube, introduce as much strong nitric acid as will cause an effervescence. Should the effervescence threaten to become explosive, the reaction may be checked by the further addition of alcohol, and when the reaction appears to decline too much, it may be re-excited by an additional quantity of acid. By these means, without applying heat, a quantity of nitric* ether will soon be condensed in the refrigerated bottle. To convert this ether into a liquid, fully equal to the officinal sweet spirits of nitre, let it be mingled with seven parts of alcohol, and four of water.

The colder the freezing mixture, the greater will be the product; yet more or less may be obtained by refrigeration with cold water.

It may be proper to mention, that at the bottom of the phial an aqueous acid liquor is deposited, upon which the ether swims, and from which it should be carefully separated.

* The proper appellation of this ether being unsettled, I adhere to that generally used.


C
C
R

ARTICLE XX.

Description of an Electrical Machine, with a Plate four feet in diameter, so constructed as to be above the Operator: also of a Battery Discharger employed therewith: and some Observations on the Causes of the Diversity in the Length of the Sparks erroneously distinguished by the terms Positive and Negative. By R. Hare, M. D., &c., &c., &c.

THE opposite engraving represents a machine with a plate four feet in diameter, which I have recently constructed so as to be permanently affixed to the canopy over the hearth of my lecture room.

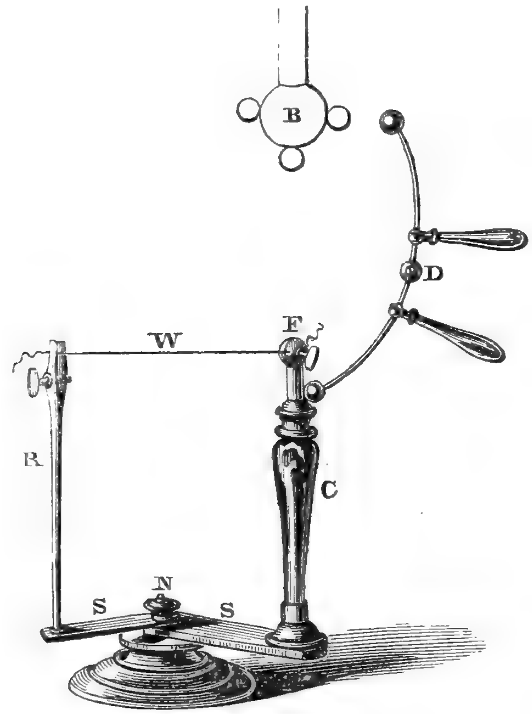
This situation I have found convenient even beyond my expectations, as the machine is always at hand, yet never in the way. In lecturing, with the aid of a machine on the same level with the lecturer, one of two inconveniences is inevitable. Either the machine will occasionally be between him and a portion of the audience, or he must be between a portion of the audience and the machine. Situated like that which I am about to describe, a machine can neither hide the lecturer, nor be hidden by him. With all its power at his command, while kept in motion by an assistant, he has no part of it to reach or to handle besides the knob and sliding rod of the conductor, which are in the most convenient situation.

The object of this machine being to obtain a copious supply of electricity for experiments, in which such a supply is requisite, it was not deemed necessary to insulate the cushions and the axis, as in the electrical plate machine which I employ for experiments requiring insulation.*

The prime conductor is supported and insulated by means of wooden posts covered by stout bell glasses, so that the summits of the latter are between those of the posts and the inner surfaces of caps attached to the conductor. By these means the glass is subjected to pressure, but is liable to no strain. Such a support combines the advantages both of wood and glass. At C C, are the collectors. R represents a sliding rod, which may be drawn out to such an extent as to be brought in contact with any apparatus placed under it upon the table.

In fact, the large rod in which the rod R slides may be slipped up to any elevation through the hole in the brass ball which sustains it.

DR. HARE'S BATTERY DISCHARGER FOR DEFLAGRATING WIRES.



This apparatus is employed by me in lieu of Henley's universal discharger; being better adapted to my apparatus, and mode of ope-

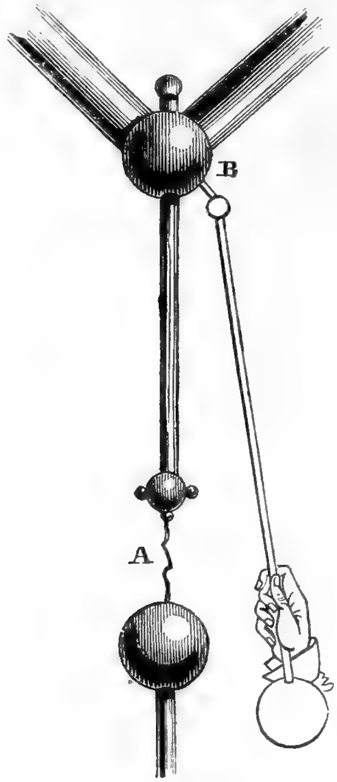
* See Silliman's American Journal of Science for 1828, vol. 7, page 108; or London Philosophical Magazine for 1823, vol. 23, page 8.

rating. Two brass plates, S S, are secured to the pedestal by a screw bolt N, which passes through a hole made in each, near one extremity: the plates are thus allowed a circular motion about the bolt, so as to be set in one straight line, or in any angle with each other. On one of the plates near the extremity not secured by the bolt, a brass socket is soldered, into which a glass column C is cemented, surmounted by a forceps. At the corresponding end of the other plate, there is a brass rod R, perpendicular to the plate, and parallel to the glass column. This rod is also furnished with forceps. Between these forceps, and those at F, supported and insulated by the glass column C, a wire is stretched, which may be of various lengths, according to the angle which the plates S S make with each other. The pedestal should be metallic, or have a metallic plate at bottom, in communication with the external coating of the battery. This being accomplished, it is only necessary to charge the battery, without subsequently breaking the communication between the inner coatings of the jars, and the prime conductor, by which the charge is conveyed. In that case, touching the conductor is equivalent to a contact with the inner coatings of the jars, so far as electrical results are concerned. Hence, by causing one of the knobs of the discharger D, with glass handles, to be in contact with the insulated forceps F, and then approximating the other knob to the prime conductor B, the charge of the battery will pass through the wire W, as it cannot descend by the glass column, nor reach the operator through the glass handles. These should be longer than represented in the cut.

LONG ZIGZAG OR ERRATIC SPARK, CONTRASTED WITH THE SHORT STRAIGHT SPARK.

"The cause of this difference between the lengths of the two electricities, we have no means of explaining."—*Thompson's work on Heat and Electricity.*

The object of the engraving on the following page is to represent the different forms and lengths of the electric spark, which take place between a large and a small ball, accordingly as they are made negative or positive. The long and zigzag, or erratic spark A takes place between a small ball attached to the positive pole, and a large one associated with the negative pole. The short straight spark B is eli-



cited under circumstances the reverse of those just mentioned. They are represented as simultaneous, but, with the same machine, can of course, only be obtained in succession.

In no respect do the phenomena of mechanical electricity appear more favourable to the Franklinian theory, and more inexplicable, according to the doctrine of two fluids, than in the diversity of the electrical spark in passing between a small and a large metallic ball, according to the manner in which the balls are associated with the positive or negative poles of the machine. When the small ball is attached to the positive pole, the spark is long, comparatively narrow, and of a zigzag shape, such as lightning is often seen to assume; but when the situation of the balls is reversed, the spark is straight and thick, not one-third as long, and nothing of a zigzag shape can be observed in it.

According to the Franklinian theory, when any body is more highly charged with electricity than the adjoining bodies, the excess of the fluid is attracted by them, while it is inadequately repelled by the inferior quantity of the electric fluid, with which they are imbued. It follows that when a small globe is made positive in the neighbourhood of a large one, the excess of electric matter in the former, is attracted by all the negatively excited metal in the latter. When the small globe is made negative, the metal of which it consists attracts all the electric matter in the large globe. Hence there is this difference in the two cases; the small globe being positive, a comparatively small *movable mass* of electric matter, is attracted by a large immovable mass of metal: the small globe being made negative, a large *movable mass* of electric matter is attracted by a small immovable mass of metal. The charge being in both cases the effect of the same machine; the attractive power must be as great in one case as in the other. The forces by which the masses are actuated being therefore equal, it is quite reasonable that the greatest projectile power should be attained, when the small mass is movable. In that case, it will require less air to be removed in order to effect a passage.

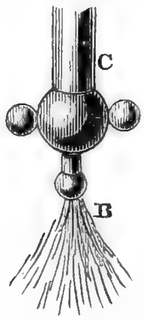
There is an analogy between the difference which I suppose to exist in the case under consideration, and that which may be observed between the penetrating power of a rod which is blunt, and one which is pointed.

It remains to show why a large mass of electric matter will be discharged in a spark when there is sufficient proximity, although that electric matter be situated in the large globe, and attracted by the other, under circumstances in which, as above stated, it would not pass without that proximity.

It must be evident that attraction increases, as the distance between the bodies which exercise it lessens. Of course the attraction of the small globe must always act more powerfully on those portions of the electric fluid, which occupy the nearest parts of the positively excited globe. But this difference of distance, and consequent diversity of attraction, increases as the globes are approximated. Thus that portion of the electric fluid which sustains this pre-eminent attraction, will be accumulated into a conoid; the acuteness of which, and attraction causing the acuteness, increasing with the proximity, there will at last be sufficient projectile and penetrative power to break through the air, and thus open a passage for the whole of the quantity attracted by the small negatively excited globe.

When, by the process last described, the fluid is made to leap through a comparatively small interval, by the concentrated attraction exercised by a small negative ball upon the expanded surface of electric matter diffused through a large globe, the air does not become sufficiently condensed to resist it before it reaches its destination, and, of course, it cannot assume the erratic form which would arise from repeated changes in its course, as in the instance of the long spark.

OF THE ELECTRICAL BRUSH.



When the machine is in active operation, and the prime conductor insulated; from a small knob attached to it, as at B, in the figure, the electricity will be so sent off, as by the concomitant light to exhibit the form of a luminous brush, as represented in this figure at B. For the production of this phenomenon, it is necessary that the electric fluid shall be condensed into a small prominent mass, so as, agreeably to the preceding explanation, to have great penetrating power. This it cannot possess, when, with the same intensity in the generating power, a large ball is positively electrified. In that case, the electric column presents a front too broad to procure a passage through the surrounding non-conducting air. A small ball, negatively electrified, can only be productive of a diffuse attraction for the electricity in the atmospheric medium around it; so that it has less ability to create any penetrating power, than when acting upon the electricity in a comparatively large globular conductor, as in the preceding illustration. Hence, when the knob is on the negative pole, it may be productive of a luminous appearance in its immediate vicinity, where the electric matter, converging from the adjoining space, becomes sufficiently intense to be productive of light; but it does not produce the striking appearance of the luminous brush.

As, agreeably to Du Fay's theory, the knob, whether vitreously or resinously electrified, is surcharged with an electric fluid, the projectile power ought to be as great in the one case as in the other; and the long spark and the brush, should be producible in either case.

ON SOME INFERENCES FROM THE PHENOMENA OF THE ELECTRIC SPARK, IN A RECENT WORK ON HEAT AND ELECTRICITY.

By the Author of the preceding Article.

In his valuable work on heat and electricity, Dr Thompson states that if a long spark be taken between two knobs, as when severally attached to the positive and negative conductors of the electrical machine; the portion of the spark near the positive knob exhibits all the characters of positive electricity, while the remaining portion proceeding from the other knob displays all the characters of negative electricity. Although the learned and ingenious author does not state what differences there are between the different portions of the spark, and wherefore, if any exist; he can, without a petitio principii, assume that they are such as to justify his conclusion. He proceeds to allege that there can be no doubt that every spark consists of two electricities; which, issuing severally from their respective knobs, terminate their career by uniting at the non-luminous portion of the spark, which is at a distance from the negative knob, of about one-third of the interval. Upon these grounds he infers that the positive electricity occupies two-thirds of the length of the spark, the negative one-third.

I presume that, agreeably to the theory which supposes the existence of two fluids, when the equilibrium between oppositely excited surfaces is restored by a discharge, whether in the form of a spark or otherwise, there must be two jets or currents passing each other; the one conveying as much of the resinous as the other does of the vitreous electricity. Of course no part of a spark can be more negative than it is positive, nor more positive than it is negative. Upon this ground, a suggestion of the same author, that the diminution of light near the middle of the spark results from the combination of the different fluids at this point, appears to me injudicious, since there is as little ground for supposing the union of the fluids to take place there as elsewhere. But admitting that the union does take place as supposed, is this a reason for the observed diminution of light? If, when isolated, either fluid is capable of emitting a brilliant light, should not their co-operation increase the effect? If, after their union, they do not shine, it can only be in consequence of their abandoning, at that moment, all the light with which they were previously associated. It cannot be imagined that the light accompanying one should neutralize that accompanying the other.

In deflagrating, by voltaic electricity, a wire of uniform thickness, equally refrigerated, the most intense evolution of heat and light is always midway.

In truth, the theory which the learned author sanctions, requires two postulates so irreconcilable, that unless one be kept out of view, the other cannot be sustained. It requires that the fluids should exercise an intense reciprocal attraction adequate to produce chemical affinity, and of course, enter into combination when they meet, and yet rush by each other with inconceivable velocity, not only through the air, but also through the restricted channel afforded by a small wire. If the fluids combine at a point intervening between the surfaces from which they proceed, what becomes of the compound which they form? Is it credible that such a compound would afford no indication of its existence? But, again, how are two surfaces, the one previously deprived of a large portion of the negative electricity naturally due to it, the other made as deficient of the positive fluid, to regain their natural state? By a combination midway, the resinous and vitreous surcharges might be disposed of, but whence could the vitreous and resinous deficiencies be supplied?

Dr Thompson, in common with the great majority of modern chemists, ascribes chemical affinity to the attraction between the two electricities combined with ponderable particles. As the combinations between such particles take place only in definite proportions, would it not be consistent that the fluids which give rise to them, should combine agreeably to those laws? But if the electrical compound, formed of the vitreous and resinous electricities, be decomposable by induction, as the theory in question requires, its constituents must be capable of uniting in every proportion.

Agreeably to the late investigations of the celebrated Faraday, equal quantities of the electric fluid are evolved by analogous chemical changes, in equivalent weights of different ponderable bodies. It may therefore be inferred, that in entering into combination the electric fluid is obedient to those laws of definite proportion which regulate other substances.

ARTICLE XXI.

On the Causes of the Tornado, or Water Spout. *By R. Hare, M. D., &c., &c., &c.*

In July last, I visited the scene of the tornado, which had in the previous month produced so much damage in and near New Brunswick, New Jersey, and heard it described by various witnesses, and have likewise been edified by the observations made respecting its effects by professors Henry, Torrey, Johnson and other sagacious and learned observers, and especially those of my friends, professor A. D. Bache, and Mr Espy. Probably in no other instance have the effects of a tornado been so faithfully and skilfully traced, ascertained and registered. Professor Bache regularly surveyed the path of the devastating agent, and ascertained the bearings of the various bodies prostrated by it, so as to make several accurate plots.* From an examination of these, the proximate causes of the changes effected, are those of a vertical current at the centre or axis of the tornado, and of a horizontal conflux of the air towards that axis from the surrounding space. Some trees appear to have been thrown down on the approach of the hiatus, both directly in front of it and on either side; some fell at right angles, others obliquely to the path. Hence they were found to have a great variety of bearings, but always pointing towards the path.

* I hope that these plots will appear in this volume.

The time of their falling, and consequently the direction agreeably to the observations of professor Bache, appear to have been determined not only by the extent of the force to which they were exposed, but likewise by the strength of their roots, or the degree of protection afforded them by other bodies, trees or houses for instance. On these accounts, neighbouring trees, falling at different times, had different bearings ; but that they all fell towards the point occupied by the axis of the tornado at the time of their overthrow, appears to be consistent with the facts. In one instance, both professor Bache and Mr Espy observed that the post of a frame building, being dislodged from the stone on which it rested, was first moved towards the path of the tornado in one direction about eighteen inches, marking its course by a furrow in the ground, and afterwards moved in another direction, nearly at right angles to the former, leaving a similar indication of the course in which it had moved. Intermediately between the time when the tornado bore in those directions, the frame was protected bya house.

While the phenomena above described sufficiently indicate the existence of a horizontal conflux of the air, that of a vertical force was demonstrated by the transportation of the debris of the houses and trees, as well as lighter bodies, to a great distance. A lady's reticule was carried seven miles from New Brunswick, and a letter twenty miles. The piece of timber, technically called the plate, on which the rafters of the roof of a meetinghouse in New Brunswick rested, was carried nearly a quarter of a mile, and lodged in some trees beyond the Raritan. The fields, on the other side of that river, were strewed with shingles torn from the houses in the town.

After maturely considering all the facts, I am led to suggest that a tornado is the effect of an electrified current of air, superseding the more usual means of discharge between the earth and clouds in those sparks or flashes which are called lightning. I conceive that the inevitable effect of such a current would be to counteract within its sphere the pressure of the atmosphere, and thus enable this fluid, in obedience to its elasticity, to rush into the rarer medium above.

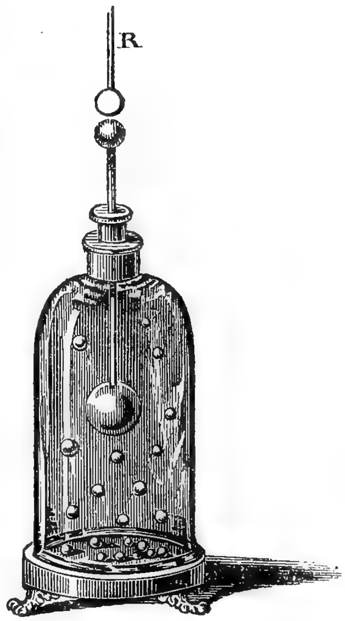
It will, I believe, be admitted, that whenever there is sufficient electricity generated to afford a succession of sparks, the quantity must be sufficient, under favourable circumstances, to be productive of an electrical current; and that light bodies, lying upon one of the electrified surfaces, may be attracted more or less by the other.

The phenomena of the rise and fall of electrified pith balls, called electrical hail, sufficiently justify this last mentioned statement; while the continuous stream is illustrated by the electrical brush, or the blast of air produced by a highly electrified point.

It will also be conceded, that thunder and lightning are caused by discharges of electricity between the earth and clouds, analogous to those of a Leyden jar or pane; the air performing the part of an electric in place of the glass, while the cloud acts as a coating.

It follows that the phenomena above mentioned as liable to arise between oppositely electrified bodies, may be expected to take place between the clouds and the earth, with effects as much exceeding those produced by human agency, as the snap and spark of an electric battery are exceeded by thunder and lightning. If in the one case pith balls and other light bodies are lifted; in the other, water, trees, houses, haystacks and barns may be powerfully affected.* If from a point electrified by a human contrivance, a blast of air is induced; it is as-

* This figure affords an illustration in miniature of the rise and fall of bodies situated between oppositely electrified surfaces, which, in the gigantic operations of nature, are conceived to be the exciting cause of the tornado. The phenomena represented by it are designated in Pixii's catalogue as "grelé electrique," and may be thus explained. A metallic rod supports one ball within the bell glass, another without, so as to be in contact with the knob of another rod R, proceeding from the conductor of an electrical machine in operation. The brass ball being by these means intensely electrified, attracts some of the pith balls which lie upon the metallic dish in which the bell is situated, and which should communicate with the cushions of the machine. As soon as the pith balls come into contact with the electrified ball, becoming similarly excited, agreeably to the general law they recede from each other and are attracted by the oppositely electrified dish. Reaching the dish, they attain the same electrical state as at first, and are, of course, liable to be attracted again.



suredly not unreasonable to ascribe to the analogous electrical apparatus of nature, aided by the elasticity of the air, a vertical hurricane. It was under the well founded impression that lightning may be superseded by a current, that we have been instructed by Franklin, to surmount our lightning rods by metallic points, by which electrical discharges from thunder clouds are expected to be conveyed to the earth gradually, which might otherwise pass in sparks of lightning of a formidable magnitude.

If, then, it be demonstrated that a continuous discharge of electricity may become the substitute for lightning, and that within the sphere of the discharge the air may be so lifted as to counteract its gravity; it is in the next place only necessary to advert to facts perfectly well known, in order to point out a cause of acceleration sufficient to account for the well known violence of the tornado.

At the height of fifteen miles, the air has been ascertained to have less than one-thirtieth of the density of the stratum next the earth. Of course this substratum would exercise a force nearly equal to the atmospheric pressure, or about fourteen and a half pounds to the square inch, in order to attain the space occupied by the rare medium, to which allusion has been made. It follows that if the weight of the superincumbent air were removed or counteracted, that the inferior stratum would rise with explosive violence.

While the air is thus carried upwards by the concurrent influence of electrical attraction, and the reaction of its own previously constrained elasticity; other bodies are lifted, both by electrical attraction, and the blast of air to which it gives rise. Hence houses within the sphere of the excitement are burst by the expansion of the air which they contain, their walls being thrown outwards, and their roofs carried away; while, by the afflux of the atmosphere requisite to the restoration of its equilibrium, trees, houses and other bodies are thrown inwards towards the vertical current, from before, as well as from either side.

When once a vertical current is established, and a vortex produced, I conceive that it may continue after the exciting cause may have ceased to act. The effect of a vortex in protecting the space about which it is formed, from the pressure of the fluid in which it has been induced, must be familiar to every observer. In fact, Franklin ascribed the water spout to a whirlwind produced by the concourse of the atmosphere to a given point. His hypothesis was, as I conceive, unsatisfactory, because it did not assign any adequate cause for the concentration of the wind, or for the hiatus which was presumed to be the cause. This deficiency is supplied, if my suggestions be correct.

One fact, of which I am myself a witness, cannot be explained without supposing a gyratory force. About six feet of a brick chimney, without being thrown down, were so twisted on the remaining inferior portion as to be left with its corners projecting.

I have hardly deemed it necessary to advert to the cause of the progressive motion of a tornado, since that would appear evidently due to the current of the atmosphere within which it may be created.

I believe that the electrical excitement which gives rise to atmospheric discharges of electricity, in whatever form they may occur, is usually ascribed to the chemical changes taking place in the atmosphere; especially the formation or condensation of vapour.

Another view of this subject has suggested itself to my mind. It is known that the atmosphere acts generally as an electric, while the earth acts as a conductor of electricity; and since the electric fluid passes through an exhausted receiver with great facility, it results that the rare medium which exists at a great elevation, is equivalent to another conductor. Hence it is evident that there are three enormous concentric spaces, of which that which is intermediate contains an electric, to which the others may act as coatings. When the tendency of electric fluid to preserve an equilibrium is taken into view, I believe myself justified in the inference, that not only the space occupied by the globe, but the region beyond our atmosphere, or where the air is sufficiently rare to act as a conductor, must abound with electricity. Thus the atmosphere is situated between two oceans of electricity, of which the tension may often be different. Between these electric oceans, the clouds, floating in the non-conducting air, must act as movable insulated conductors; and from the excitement consequent upon induction, chemical changes, or their proximity to the celestial electric ocean, must be liable to be electrified differently from each other, and from the terrestrial electric ocean.

The phenomena of thunder storms may arise, from the passage of electricity from one electric ocean to the other being facilitated by an intervening accumulation of the clouds, or in consequence of discharges from one insulated congeries of clouds to another through the earth.

The aurora borealis may arise from discharges from one ocean to the other of electricity, which, not being concentrated by its attraction for intervening clouds within air sufficiently dense to act as an electric, assumes the diffuse form which characterizes that phenomenon.

Falling stars may consist of electric matter, in transitu between one portion of the celestial electric ocean and another, tending to restore the equilibrium when disturbed. They may, in fact, consist of electric matter, passing from one mass of moisture to another; as it may be imagined that in an expanse so vast, in which the tension is so low, there may be a great diversity as respects the quantity of moisture existing in different parts. Indeed, it may be conceived that at times the clouds, insulated from each other, may make their reciprocal discharges through the region occupied by the celestial ocean.

I have been informed by my intelligent friend, Mr Quinby, who resided for some time in Peru, at an elevation of fifteen thousand feet above the level of the ocean, that the clouds in that elevated region are far more electric than in the lower country of the same latitude; and that, on this account, it was considered as dangerous, at times, to travel in the "*sicrras*," or table land. Possibly thunder storms are more frequent in warm weather, in consequence of the greater elevation which the clouds then attain, and their consequent approximation to the celestial ocean of electricity.

Consistently with the hypothesis which I suggested in my essay on the gales of the United States, the enduring rains which accompany those gales are attributed to the contact of an upper warm and moist current of air, with a lower current of the same fluid at an inferior temperature, and moving in an opposite direction. It would follow that, on such occasions, the electricity of the upper region would be diffused among the clouds within the upper stratum, without reaching those existing within the lower current. But in such cases neither stratum would be sufficiently insulated and restricted in its extent to transmit the electricity in a concentrated form, or to be liable to the intense excitement necessary to produce a tornado or lightning.

FACTS AND OBSERVATIONS RESPECTING THE TORNADO WHICH OCCURRED AT NEW BRUNSWICK, NEW JERSEY, IN JUNE LAST, ABSTRACTED FROM A WRITTEN STATEMENT MADE BY JAMES P. ESPY, M. A. P. S.

By the Author of the preceding Article.

The tornado was formed about seven and a half miles west of New Brunswick, and, moving at the rate of about twenty-five or thirty miles in an hour, terminated suddenly at Amboy, about seventeen and a half miles from the place of its commencement. It appeared like an inverted cone, of which the base was in the clouds, and the vertex upon the earth. It prostrated or carried off every movable body within its path; which was from two hundred to four hundred yards wide. Trees which were embraced successively within its axis were thrown down in a direction parallel to its path; those on either side always pointing towards some point which had been under its axis. Houses were unroofed, and, in some instances, unfloored; in others, their walls were thrown down outwards, as if burst by an explosion. There are two facts stated by Mr Espy, and confirmed by professor Bache, which demonstrate fully the existence of an hiatus. In a house which was exposed to the vertical influence of the tornado, a sheet was lifted from a bed, and carried into a fissure made in the southern wall, which subsequently closed and retained it. The same result was observed in the case of a handkerchief, similarly fastened into a fissure in the northern wall. In some instances, frame buildings were lifted entire from their foundations. Joists and rafters were torn from a house and thrown down at the distance from it of about four hundred yards, and in a direction opposite to that in which the trees not lifted from the earth's surface were prostrated. Of course lighter bodies, such as shingles, hats, books and papers, and branches and leaves of trees, were carried to much greater distances. There was no general rain, but hail and rain accompanied the fall of the other bodies. The tornado lasted, in any one place, for but a few seconds: the whole of the damage done at a farm having been accomplished, as the farmer stated, while he was passing from the front to the rear of his mansion, so that, by the time that he reached the back door, there was a perfect calm. Meanwhile, his house and barn were unroofed, and all the neighbouring trees thrown down. The noise which accompanied the phenomenon was by every witness described as terrific, being best exemplified by the rumbling of an immense number of heavy carriages. Every object in its path was bespattered with mud on the side towards that from which it advanced. Houses looked as if roughcast, and individuals were so covered with dirt as to be disguised.

Some thunder and lightning attended the tornado. Some trees, which resisted the onset, yielded subsequently; and hence were piled upon those which had fallen earlier. The weaker trees were undermost, and pointed in the direction in which the tornado approached; while the stronger were on the top, pointing in the direction in which it moved away.

Four different places were noticed, where all the trees lay, with their summits directed to a common centre. In the middle of one of these localities, the house was unroofed, and the handkerchief and sheet were lodged within the fissures in the walls, as already stated. The windows in the same house were all broken, and much of the glass thrown outside. From the evidence, Mr Espy infers that the apparent height of the tornado was about a mile. He states that there were, on the same day, two other tornadoes about seventeen miles apart; and of which the nearest was about the same distance from that of New Brunswick. He conceives that the phenomena all concurred to demonstrate an "inward motion from all directions towards the centre of the tornado, and an upward motion in the middle." These statements of Mr Espy are confirmed by professor Bache.

One fact of some importance has not been mentioned by Mr Espy, which was observed by persons who were upon the ground during, or soon after the catastrophe. I allude to the partial withering of the foliage of those small trees or shrubs, which, from their suppleness, were like the reed in the fable, neither uprooted nor overthrown. This unpleasant effect was perceptible when I visited the scene. Each leaf was only partially withered. As it would be inconceivable that mechanical laceration could have thus extended itself equably among the foliage, a surmise may be warranted that the change was effected by the electricity associated with the tornado.

Concluding Remarks by the Author of the Article.

I ought, perhaps, sooner to have acknowledged that I am aware that it has often been suggested that water spouts might be caused by electricity; but the conjecture has not, as far as my information goes, been heretofore supported by any satisfactory explanation as to the mode in which such a tremendous power could arise from that source. That I am warranted in this impression, will, I trust, appear evident from the circumstance that two of the most distinguished among the late writers in the department of science to which the subject belongs, seem to admit, or to demonstrate, their inability to afford any explanation. I allude to Pouillet, and Despretz.

In his treatise on meteorology, Pouillet introduces two narratives respecting tornadoes, which were analogous in every essential point to that of New Brunswick. Especially the existence of an hiatus is proved by the allegation that the walls of prostrated houses were thrown down outwards. A labourer was first urged forwards, in the next place lifted, and lastly overthrown.

The learned and ingenious author concludes with these remarks. "Comment cette puissance, quelquefois si prodigieuse, peut-elle prendre naissance au milieu des airs? C'est une question, il faut de dire, à laquelle la science ne peut faire aucune réponse précise. De toutes les conjectures vagues et hasardées, que l'on peut faire sur l'origine de ce météore, la moins invraisemblable est peut-être celle que le regarde comme un tourbillon d'une excessive intensité. Mais une discussion sur ce point nous semblerait prématurée; il faut multiplier les observations, et constater avec plus de précision toutes les circonstances de ces phénoménes."—*Elemens de Physique Experimentale et de Météorologie, vol. 2, p. 727.*

All the information respecting tornadoes afforded by Despretz is comprised in the following paragraphs, which I quote in his own words.

"*Trombe.* La trombe se montre en mer et sur la terre; tantôt elle semble sortir du sein de la mer, et s'élève jusqu'aux nuages; tantôt elle descend des nuages jusqu'à terre.

"C'est une colonne d'eau cônique qui tourne sur elle-même avec une grande vitesse; elle a quelquefois jusqu'à plus de deux cents mètres de base. Elle est très-commune entre les tropiques: les navigateurs passent rarement près des côtes de Guinée sans en apercevoir plusieurs.

"Les trombes produisent des effets terribles; elles déracinent les arbres, renversent les faibles habitations, soulèvent les voitures, etc.

"On peut se faire une idée des trombes par les tourbillons de pouissiére qui se forment tout à-coup, en été, sur les routes, et qui tournent sur eux-mêmes avec une grande rapidité."—*Traité Elementaire de Physique, paragraph* 656, *page* 828, *par C. Despretz.*

In Nicholson's Journal, quarto series, London 1797, vol. 1, page 583, there is an interesting account of some tornadoes seen from Nice, illustrated by engravings, by M. Michaud, who appears to consider them as the effect of electricity, and infers that he could produce the phenomenon in miniature by the aid of a machine, as thunder and lightning are by the same means illustrated. This I have found to be erroneous, as far as my experience goes, and from a cause which is, agreeably to my hypothesis, quite evident. I mean the absence of the co-operating influence of the air when emancipated by electric attraction from the confinement arising from its own weight.

The theoretic remarks of Michaud are very brief, and, to me, scarcely intelligible, as he does not inform us in what way he supposes the electric fluid to operate.

I have understood, since I conceived my hypothesis, that Beccaria ascribed water spouts to electricity, but I have not had the advantage of learning by what reasoning he justified his inferences. However, should it appear that I have made, through the want of information, any undue claim to priority, I shall cheerfully do justice to any philosopher whose speculations I may have overlooked.

ARTICLE XXII.

Description of an Air Pump of a new construction, which acts either as an Air Pump, or a Condenser, or as both; enabling the operator to exhaust, to condense, to transfer a Gas from one cavity to another, or to pass it through a Liquid. By R. Hare, M. D., &c., &c., &c.

THIS pump has one iron chamber,* one piston, and four valves. When in operation, it is always simultaneously exhausting and condensing; and, of course, accomplishes as much, in a given time, as two chambers of the usual construction, of the same calibre and stroke. A suction valve is placed at each end of a steel rod, which slides through the packing of the piston,† so as to be air tight, and to be pressed in opposite directions alternately. It is of such a length, that while it forces one valve, towards which the piston moves, against its seat, closing a corresponding aperture, it withdraws the other valve from its seat, and, consequently, opens the aperture with which this valve corresponds. Hence, with every reversal of the motion, the aperture previously opened will be shut, while that previously shut will be

* The diameter of the chamber in the instrument represented in the figure is three inches; the length is ten and a half inches, allowing a stroke of about eight inches, taking off the thickness of the piston. In order to render this instrument insusceptible of injury from mercury, it was constructed altogether of iron or cast steel.

† This contrivance was suggested to me by an excellent pump with glass chambers, obtained many years ago from Pixii. In that pump a steel rod is made to open and shut one valve: in mine the same rod opens and shuts two valves.

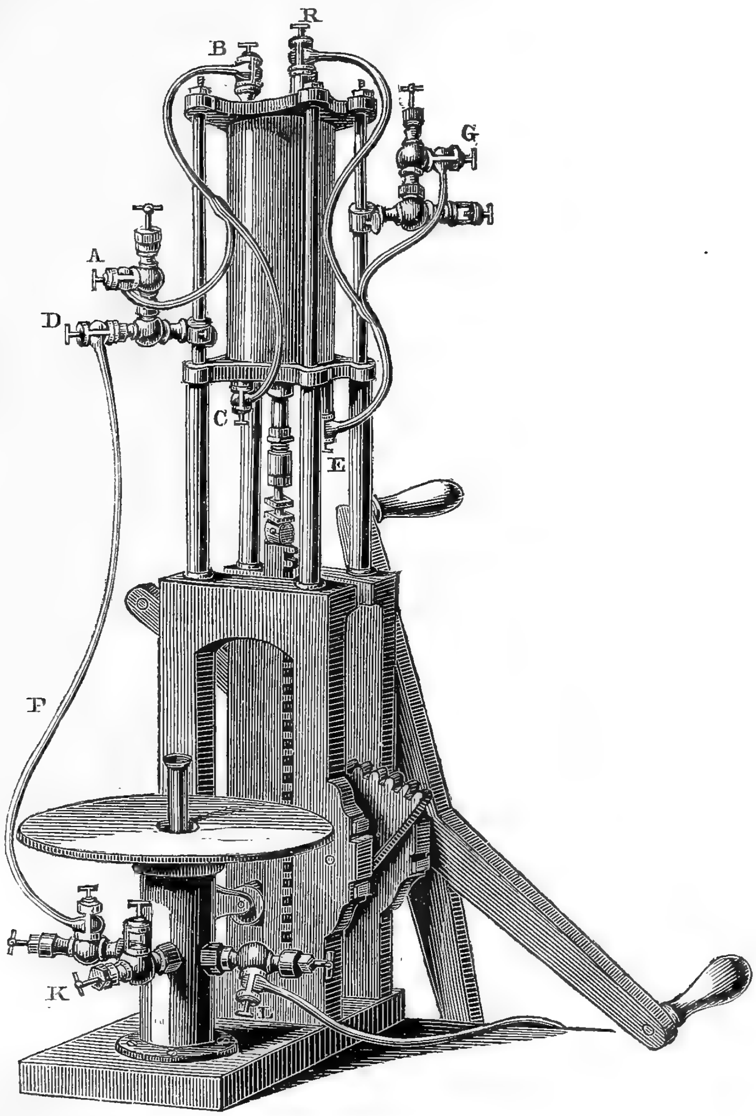
opened. Between the apertures thus alternately opened and shut, and the valve cock A, a communication is made by means of a forked leaden pipe, communicating with the valve cock at A, and with the apertures at B and C. The valve cock, by means of a gallows screw D, communicates, when desirable, with any receiver by another flexible leaden pipe P.

Two other analogous and corresponding apertures E R, which communicate in like manner with a valve cock G, are furnished with two valves opening outwards. These, when not subjected to any pressure from within the chamber, are kept in their places by spiral springs. They act as valves of efflux, and, like the valves in other condensers, are opened by the pressure of the air condensed by the piston as it approaches them, and are shut by the springs when the piston moves in the opposite direction. It is well known, however, that this mode of opening valves, if unassisted, always allows a small portion of condensed air to remain in that portion of the chamber and of the passage leading to the valve, which the piston cannot be made to occupy entirely. This disadvantage is diminished in the case of the valves which I am describing. A stem proceeding from each valve enters the chamber so far, as that the piston cannot finish the stroke without coming in contact with the stem, and moving the valve sufficiently to allow the air to escape, without suffering any resistance from the valve and its spring.

The means by which the apertures of the suction valves communicate with a valve cock A, and may be made to communicate with the receiver through the pipe P, have been explained. By like means the communication, existing between the apertures of the valves of efflux and a valve cock G, may be extended from this valve cock to any receiver. In fact, it is only necessary to vary the situation or number of the pipes, by which communications with the chamber are effected, in order to cause the apparatus to perform the part of an air pump, a condenser, or both. When employed to transfer air, it would be more correctly designated as a forcing air pump, than as a condenser.

The disk of brass in front of the pump, serves as an air pump plate, when connected with the pump by means of the pipe P, as represented in the drawing. It is supported on a hollow brass cylinder, furnished

DR HARE'S SUCTION AND FORCING AIR PUMP.



with valve cocks as at K L, in order to allow various experiments to be performed by means of the tube in the axis, surmounted by a cup of copper. The tube being open at the lower end, the cup is accessible to an incandescent iron. The contrivance facilitates the exposure of substances to heat, either in vacuo, or in any gas. When boric acid and potassium are thus heated, boron is evolved. By means of a similar arrangement, heating chloride of calcium with potassium, I obtained a potassuret of calcium, which decomposed water and yielded a solution which was rendered milky by carbonic acid.

When a glass globe of fifteen gallons is exhausted over this plate, and filled with oxygen gas, phosphorus having been previously placed in the copper cup, on heating the phosphorus, a combustion ensues of transcendent splendour.

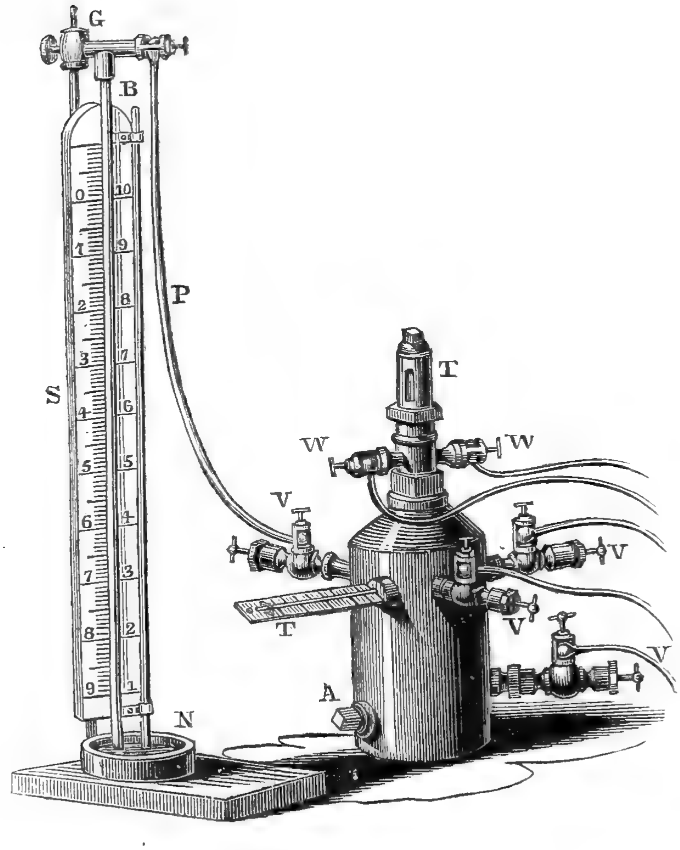
For this and other experiments, the hollow cylinder, which supports the air pump plate, may be screwed into a hole in a table and placed at any convenient distance from the air pump. With this view, there is a conical screw cut upon the lower end of the cylinder.

The mechanism by which the piston is moved, is too obvious to need description. There is, however, a peculiarity in the construction of the piston rod, which is of great utility. The rod is hollow, having been sufficiently reduced in diameter from a piece of gun barrel by the wire drawing process. The bore of this *hollow* rod is occupied by a solid rod, which extends from the metallic disk, at the farther end of the piston, to the rack. To the other disk, the hollow rod is fastened. The leather packing between the disks, being turned in the lathe so as to fit the calibre of the chamber accurately, is made more or less tight by the action of a screw just above the rack. Hence the pressure may be regulated without taking the pump apart, which is always troublesome, and, at some periods impracticable within the time at command.

With respect to the efficacy of this pump, satisfactory proof was given some time since, at the Franklin Institute, when it raised the mercury very near to the height of that in the Torricellian tube.

Having been in possession for many years of an elegant air pump with glass chambers furnished by Pixii, we have been induced to give the preference to the new instrument, in all cases where a perfect exhaustion has been desirable.

Of the three valve cocks, one usually communicates with a gage; since, instead of an instrument of that nature permanently associated with the pump, and which is subjected to exhaustion by means of a lateral communication with the perforation leading to the cavity of the receiver, I employ a movable barometer gage, which is made to communicate with the receiver directly. The operator is thus enabled to observe the quantity of gas in the receiver, after the communication with the air pump is arrested by closing the valve cock through which it was established. An exemplification of this method of manipulating will be afforded by the apparatus and eudiometrical process, described in the next article.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ARTICLE XXIII.

Of an Improved Barometer Gage Eudiometer. *By R. Hare, M. D., &c., &c., &c.*

About eight years ago I published an account of a hydro-oxygen eudiometer, in which the measurement of the gases was effected by means of a barometer gage. In the apparatus then employed, the receiver was of glass, and was, of course, fragile. Subsequently I employed a stout iron bottle in lieu of the glass.

The essential constituents of this apparatus are an air tight vessel, sufficiently strong, and having screw apertures for the insertion of valve cocks, V V V, a thermometer T, and a galvano ignition apparatus* W W; also a barometer gage G, communicating by a leaden tube with the vessel through one of the valve cocks.

An air pump, pneumatic cistern or trough, and reservoirs for gas, are necessary auxiliaries.

It is an important characteristic of the barometer gage eudiometer, that it is applicable on a much larger scale than any other. It is only necessary to make the requisite apertures, and tap them for appropriate screws, in order to transfer the valve cocks, thermometer and ignition apparatus, with all the essential means of operating, to any air tight cylinder of any size ; to a large cannon for instance, the mouth

* This is the name by which I have designated it in my text book.

being closed. The sources of inaccuracy, if any exist, must lessen in proportion to the result, as the quantity acted upon is augmented. It would, of course, be safer to extend the cylinder in length than in diameter.

Description of the Gage.

It is well known, that if a vertical glass tube communicate, through its upper orifice, with a receiver, while its lower orifice is situated beneath the surface of an adequate quantity of mercury, in any convenient receptacle; on exhausting the receiver, the metal will rise in the bore of the tube in proportion to the quantity of air removed. Hence, if zero of the ascending column of degrees, counting upwards from one to ten, be placed on a level with the surface of the mercury in the receptacle at the foot of the gage tube G, the quantity of gas condensed or withdrawn will be as the number of degrees opposite the surface of the column of the mercury in the gage tube.

Again, supposing it were possible to exhaust the vessel perfectly, the column of mercury in the gage, would attain the height of a well filled Torricellian tube. By having such a tube by the side of the gage tube, as represented at B in the figure, its orifice communicating with the mercury of the same receptacle, and placing zero of the descending column of graduations on a level with the surface of the mercury in the Torricellian tube, the quantity of air in the receiver will always be as the number of degrees, between the surface of the mercury in the gage and the surface of the same metal in the Torricellian tube.

The scale comprises ten divisions, each containing ten subdivisions. The whole scale may therefore be estimated to divide the capacity of a receiver into ten volumes, or into one hundred, whenever the zeros of the right and left hand columns of degrees coincide simultaneously, the one with the surface of the mercury in the receptacle, and the other with that of the Torricellian column. But on this it were vain to rely, since the altitude of the Torricellian column is liable to vary while the scale remains unchanged. This difficulty is, however, easily surmounted by restricting the length of the graduated part of the scale to the minimum height of the mercurial column, or twenty-seven inches; and employing an excess of hydrogen when the quantity of oxygen is to be ascertained, and an excess of oxygen when the quantity of hydrogen, or hydrogen and carbon, are in question; the excess in either case, being made equal to the difference between twenty-seven inches, and the height of the Torricellian column. With this precaution, the quantities introduced or withdrawn, will always be to each other as the changes which they produce in the column of mercury in the gage tube. The rise of the mercury in the tube, will cause the surface of it in the receptacle D to be lower; but the breadth of this vessel is so great, and the descent of the mercurial surface in it is so inconsiderable, that no error worthy of attention is thus created.

I ought to mention, that the cavity of the gage tube ought to be so small in proportion to that of the receiver, as to create no error worthy of attention.

Description of the Galvano Ignition Apparatus.

An iron cylinder, of about an inch in bore, includes another concentric cylinder, or tube of glass. A platina wire, which, by being made the subject of a galvanic discharge, is employed to ignite the gaseous mixture, occupies the cavity of the glass. Opposite to it, two openings are made in the iron, which serve for windows, enabling the operator to see the progress of the ignition, and, consequently, to know when to break the galvanic circuit, in order to avoid fusing the wire.

Method of Operating.

In the engraving, a leaden tube is represented as making a communication between the gage tube and the cavity of the iron bottle, through one of the valve cocks. Let it be supposed that, by means of other valve cocks and tubes, like communications with an air pump, and one or more reservoirs of gas, are under the control of the operator.

In order to analyze the atmosphere, he should have at his command a communication with a bell glass containing, over water, a mixture of five parts of air and three of hydrogen; also with a reservoir of hydrogen.*

These arrangements being made, exhaust the bottles; and admitting two or three volumes of hydrogen, exhaust again. By repeating this part of the process, nothing but hydrogen will remain in the vessel. Let the zero of the descending scale be situated on a level with the surface of the mercury in the gage tube, and then admit eight volumes of the mixture, which will be known to have entered when the surface of the mercurial column has fallen to eight on that scale. All the cocks being closed, ignite the platina wire. The explosion will be known to take place, both by the flash and sharp noise which it produces. As soon as these indications are perceived, the cock communicating with the gage may be re-opened. Nearly three volumes of the mixture will be found to have disappeared, and by the time that the thermometer indicates the temperature to be in statu quo, it will be found that the deficit arising from the combustion will a little exceed that quantity.

In analysing gaseous compounds of carbon with hydrogen, this apparatus may be advantageously employed; due proportions of the carburet and of oxygen gas being previously mingled in an appropriate vessel over water. Suppose, for instance, olefiant gas were in question; one volume of it being mixed with four of oxygen: after the explosion, two volumes will be found wanting; because, in one volume of the carburet, there are two of hydrogen and two of carbon vapour. Each volume of the latter, will unite with one of oxygen, without altering its volume. The two volumes of hydrogen will take one of oxygen, and be condensed with it into water. Of course, in lieu of the five volumes introduced, two volumes of carbonic acid, and one residual volume of oxygen will remain.

By means of the forcing air pump, described in the preceding pages, the gas may be transferred to a receiver, and washed with ammonia, or milk of lime, and then allowed again to enter the iron bottle.

* The necessary mixtures are effected either by means of the volumeters or the sliding rod gas measure, of which I published engravings and descriptions in Silliman's American Journal of Science, vol. 12, page 36, 1827; and in the London Philosophical Magazine for 1828, vol. 32, page 126.

Meanwhile, by due attention to the gage, the quantity which has been absorbed may be ascertained; and consequently, the proportion of carbonic acid resulting from the oxidizement of all the carbon in the gas subjected to analysis.

Instead of employing the forcing air pump, by substituting a large valve cock for the screw by means of which an aperture in the bottle at A is closed, mercury may be introduced through a funnel, and, by its pressure, the residual gas may be easily conveyed, by a flexible leaden tube, to a receiver over the mercurial reservoir, and analyzed in the usual way. For this purpose it is necessary that the valve cocks with which the mercury comes into contact, should be of iron or steel; and, accordingly, I employ such where mercury is to be used.

The gases may be supplied, without previous measurement and admixture, by receiving them into the bottle from their respective reservoirs, and measuring them as they enter, by means of the gage.*

* I subjoin engravings of the self-regulating reservoirs which I employ in such eudiometrical experiments as are described in the preceding article; also of the calorimotor, by means

Fig. 1.

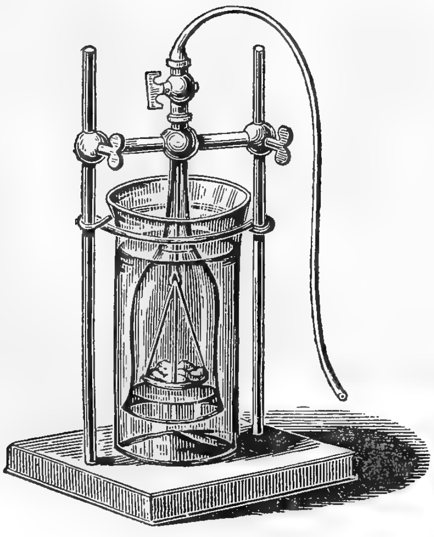
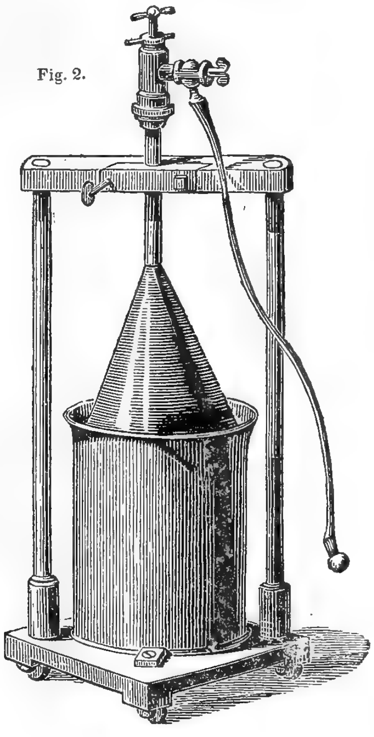


Fig. 2.



When hydrogen is employed to analyze the air, it should be the last admitted; since otherwise it is liable, from its lightness, to pre-occupy the cavity in which the platina wire is situated; so that some time would be required for its sufficient admixture with atmospheric oxygen to constitute a combustible mixture.

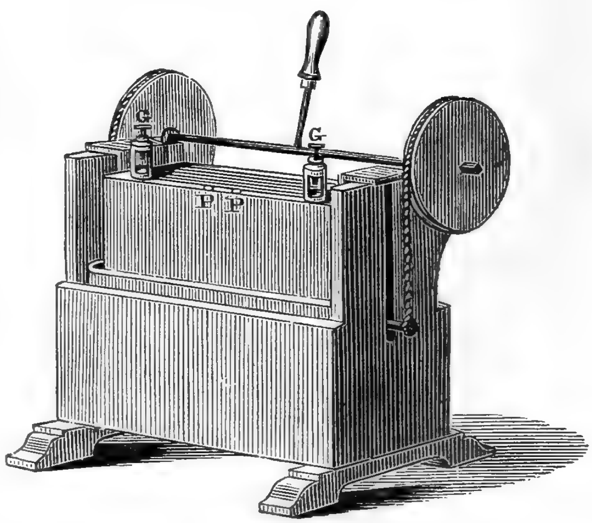
In this mode of operating, when the apparatus is once well arranged, the analysis of the air may be repeated as often as desired, and after any interval of time.

of which the ignition of the platina wire, and consequent inflammation of the gaseous mixtures are accomplished. There are two reservoirs, one of glass, fig. 1, the other of lead, fig. 2; the latter being about fifty times as large as the other.

As there is a perfect identity in principle of the construction in these reservoirs, an explanation of one will answer for both.

Suppose the glass jar to contain diluted sulphuric acid; the inverted bell, within the jar, to contain some zinc, supported on a tray of copper, suspended by wires, of the same metal, from the neck of the bell. The cock being open when the bell is lowered into the position in which it is represented, the atmospheric air will escape, and the acid, entering the cavity of the bell, will, by its reaction with the zinc, cause hydrogen gas to be copiously evolved. As soon as the cock is closed, the hydrogen expels the acid from the cavity of the bell; and, consequently, its reaction with the zinc is prevented, until another portion of the gas be withdrawn. As soon as this is done, the acid re-enters the cavity of the the bell, and the evolution of hydrogen is renewed and continued until again arrested, as in the first instance, by preventing the escape of the gas, and, consequently, causing it to displace the acid from the interior of the bell, within which the zinc is suspended.

This engraving will convey an idea of the calorimotor suitable to effect the ignition of the platina wire in the galvano ignition apparatus above described. It should contain two galvanic pairs, each consisting of two plates of zinc, 10 × 12, alternating with three of copper. The copper plates of one pair, and the zinc of the other being soldered to a common metallic strip, the other plates of zinc being soldered to one strip, the copper to another, each of the last mentioned strips is furnished with a gallows screw G G. Between these screws and those at W W, (see figure in the text) a communication is made by leaden or copper rods.



To complete the circuit, it is only necessary, to depress the handle attached to the pulleys, in order to raise the reservoir of diluted sulphuric acid, and thus to cause it to act on the plates.

ARTICLE XXIV.

On the Cause of the Collapse of a Reservoir while apparently subjected within to great Pressure from a Head of Water. By R. Hare, M. D., &c., &c., &c.

In September 1834, I was requested by Mr Haydock, a respectable and intelligent plumber of this city, to call at his shop in order to see a copper reservoir, which had collapsed while apparently subjected to internal pressure, arising from a communication with the mains proceeding from the public water-works.

For the purpose of refrigerating the contents, the reservoir was placed in spring water, at the bottom of a well, so as to be at a small depth below the surface: receiving the river water by one pipe, it was made to deliver it by another.

The pressure of the water with which the city of Philadelphia is supplied, is known to be sufficient, when at its maximum, to command the most elevated rooms in our dwellinghouses. Hence, had the reservoir been burst, it would not have excited surprise; but the converse appeared inexplicable. The figure on the next page will convey a correct idea of the reservoir as it appeared when I examined it; or subsequently, when a drawing of it was made at the Franklin Institute, to which it had been removed, at the instance of some of the members of that institution.

A is a pipe with a stop cock to allow the air to escape on first filling the reservoir. B, a pipe by which a communication with the mains of the public water-works was established. C, a pipe for delivering the water.

The height of the vessel was three feet; greatest diameter eighteen inches, least diameter twelve inches.

Some days had elapsed, during which I was unable to offer any explanation of the phenomenon; but having mentioned the occurrence to another highly respectable and intelligent plumber, Mr Ewing, he alleged that facts no less surprising had fallen within the range of his experience. He had known an opening made in a leaden pipe at one time, to be closed at another, by some unaccountable inward pressure; and, upon one occasion, a small fish to be caught in the fissure.

It then occurred to me that the phenomenon of the collapse had been the consequence of circumstances the inverse of those which are known to take place in the water ram of Montgolfier, in which water, while flowing rapidly in a trunk, being stopped suddenly in front, is made to produce a jet rising above the level of the head to which the current arrested is indebted for existence.

The momentum of the water which is in that case expended in a jet, must, in the case in which an arrestation takes place in the rear of a given portion of the stream, continue to propel that portion directly forwards, causing an hiatus or vacuum between it and the valve or cock by which the stoppage has been effected.

The inward pressure, or suction, arising from such a momentum, was demonstrated by Venturi;* and has latterly been ingeniously applied to the filling of syphons, and removal of back water from water wheels.

In this view of the subject then, we find the rationale of the collapse of the reservoir.

The current through the main being arrested at a point nearer the head than that from which the pipe supplying the reservoir proceeded,

* Nicholson's Journal, 4to series, vol. 2, page 172.

there was an hiatus produced within the main, and cavities therewith communicating, which caused the atmospheric pressure to be inadequately resisted, and consequently the reservoir, as one of those cavities, was crushed. No doubt the pressure of the spring water, in which the reservoir was situated, co-operated. At times our springs rise much nearer to the surface of the earth than at others.

When steam is made to pass through a pipe into cold water, a succession of expansions and condensations ensue, producing much noise and mechanical jarring, consequent to the alternate absorption and expulsion of the water. Agreeably to the rationale respecting the collapse of the reservoir, these effects should be productive successively of an inward and an outward pressure upon the surfaces of the pipes employed.

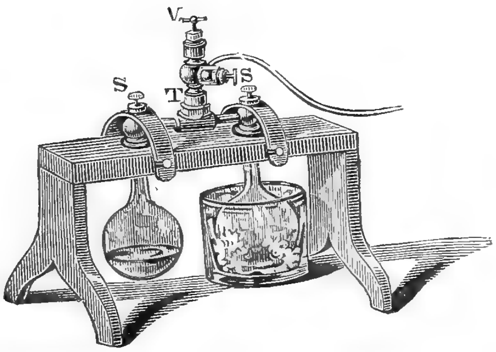
Some years ago, a pipe was submitted to me by Mr Ewing, which, while situated as above described, had been crushed by a force which seemed to have exceeded any which could, under any circumstances, be expected from the pressure of the atmosphere. Possibly an adhesion between the water and the metallic surface, may co-operate in the production of such results.

ARTICLE XXV.

Sundry Improvements in Apparatus, or Manipulation. *By R. Hare, M. D., &c., &c., &c.*

IMPROVED CRYOPHORUS.

Two flasks, of which the necks have flanged orifices, are so secured in a wooden frame, that by the pressure of screws S S, and gum-elastic disks, the orifices of a tube are made to form with them severally, air tight junctures. The orifices of the tube are furnished with brass flanges, which correspond with those terminating the necks of the flasks.



Midway between the junctures a female screw is soldered to the tube for the insertion of a valve cock V, by means of which, and a flexible tube extending to an air pump, the flasks may be exhausted, and then closed. A small quantity of water having been previously introduced into one of them, if, while the exhaustion is sustained, the other flask be refrigerated by ice and salt, the water will be frozen.*

The intelligent chemist will perceive that this apparatus may be applied to the purpose of desiccation by placing the article to be dried in one receptacle, and quick lime, chloride of calcium, or concentrated sulphuric acid, in the other. The orifice of the receptacles may be made larger without inconvenience. Two large cylinders, for instance, may be used.

I propose, as soon as I have leisure, to apply the principle illustrated by this apparatus, to the distillation or desiccation of many substances which are liable to injury when exposed to heat, or air. I conceive that there is, by means of analogous apparatus, a fruitful field for improvement in the arts. I conceive that it may be employed in the preservation of meat, milk, fruit, vegetables, and the making of cheese; also in pickling and preserving.†

* For the information of readers who may not be chemists, I subjoin the following explanation of the cause of the congelation of the water.

So long as no condensation is effected, of the thin aqueous vapour, which, when water is present, must occupy the cavity of the instrument, that vapour prevents, by its pressure, or tension, the production of more vapour: but when, by means of cold, the vapour is condensed in one bulb, its evolution in the other, containing the water, being unimpeded, proceeds rapidly. Meanwhile, the water becomes colder, and finally freezes, from losing the caloric which the vaporization requires.

According to Wollaston, one grain of water, converted into vapour, holds as much caloric as would, by its abstraction, reduce thirty-one grains from 60° F. to the freezing point; and the caloric requisite to vaporize four grains more, if abstracted from the residual twenty-seven grains, would convert them into ice.

† This figure represents a very large Cryophorus, the blowing of which I superintended;

and by means of which, about twelve years ago, I successfully repeated Wollaston's experiment.

This instrument is about four feet long, and its bulbs are about five inches in diameter.

CULINARY PARADOX, OR EBULLITION BY COLD.

This figure illustrates a new and instructive method of effecting ebullition by cold.

The apparatus consists principally of a glass matrass, with a neck of about three feet in length, tapering to an orifice of about a quarter of an inch in diameter. The bulb is bulged inwards, in the part directly opposite the neck, so as to create a cavity capable of holding any matter which it may be desirable to have situated therein. In addition to the matrass, a receptacle, holding a few pounds of mercury, is requisite. The bulb of the matrass being rather less than half full of water, and this being heated to ebullition, the orifice should be closed by the finger, defended by a piece of gum-elastic, and depressed below the surface of the mercury; the whole being supported as represented in the figure. Under these circumstances, the mercury rises as the temperature of the water declines, indicating the consequent diminution of pressure within the bulb. Meanwhile, the decline of pressure lowering the boiling point of the water, the ebullition continues till the mercury rises in the neck nearly to the height of the mercury in the barometer.

By introducing into the cup formed by the bulging of the bulb, cold water, alcohol, ether or ice, the refrigeration, the diminution of pressure, and the ebullition are all simultaneously accelerated, since these results are reciprocally dependent on each other.

The advantage of this apparatus and method of operating, lies first in the certainty and facility with which the apparatus is secured against the access of the atmosphere; and in the next place, in the index of the diminishing resistance, afforded by the rise of the mercurial column.

HYDRO-PNEUMATIC CISTERN.

Fig. 1. In Silliman's Journal will be found an engraving and description of a pneumatic cistern, which I employed in the experimental illustrations of my lectures for more than ten years; and which I should probably continue to use now, had not the command of water from the public works, put it into my power to dispense with the mechanism for keeping the water at a proper level. As I am now situated, any deficit of water is easily supplied from the pipes known here as the hydrant pipes, by which the city is supplied with water; and any excess is carried off by a waste pipe. Many chemists designate as a pneumatic trough or tub, apparatus for the purposes to which that in question is applied. Neither of these names is, in my opinion, as applicable to the apparatus which I have hitherto used, as that of cistern, to which I resorted; and although the last term be less suitable to the apparatus which I am about to describe, yet I beg leave to adhere to it for want of a better appellation.

A A, a water-tight platform, surrounded by a wooden rim, R R R R, rising above it about an inch and a half. B, C, D, three wells or cavities, each in the form of a hollow parallelopiped, with all of which the cavity bounded by the rim communicates, so that when supplied with water to the level of the waste pipe, this liquid fills the wells, and covers the platform to the depth of about three-fourths of an inch.

E, F, G, shelves, which severally move in grooves over the wells, so that they may be placed in the most convenient position. Under H is a waste pipe. At I is a hydrant pipe. K, a pipe for emptying the wells and casks, with all of which it may be made to communicate by cocks, when requisite. N, O, casks which act as gas holders, each having a communication with the cistern at Q or *q*, for letting in water from that source; the orifices being controlled by valves. By means of a pipe proceeding from its vertex, each gas holder communicates with a pipe or cock, at S or *s*.

To these gallows screws, flexible leaden pipes may be attached, for transferring gas either from one of the holders to a bell glass, or from a bell glass to one of the holders. When a communication is established between the cavities, either of these offices may be performed, accordingly as the pressure within the holder is made greater, or less, than that of the atmosphere. It will be greater when the valve for the admission of water is opened, that for letting it out being shut: and less when these circumstances are reversed.

Fig. 1.

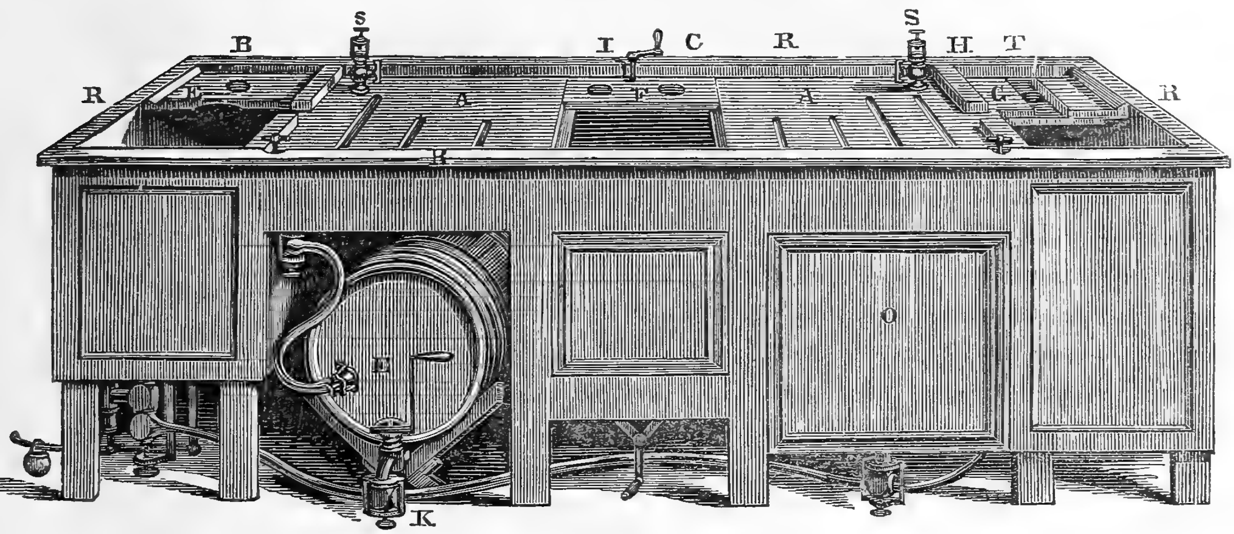
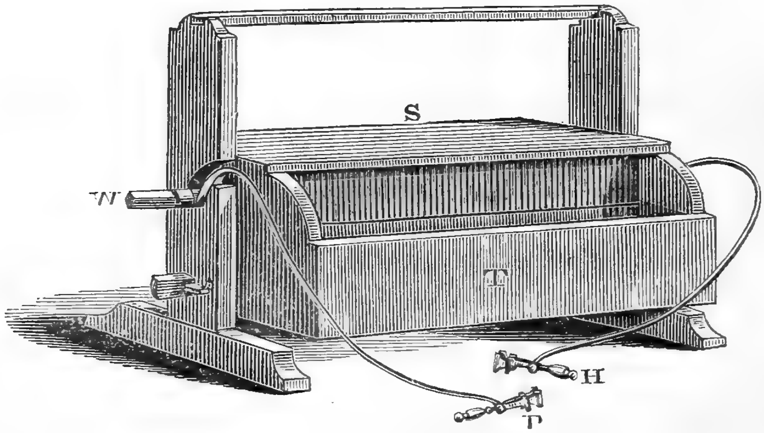


Fig. 2.

Fig. 2 affords a view of the lower side of the sliding shelf, in the wood of which it will be seen that there are two excavations, converging into holes. This shelf is loaded with an ingot of lead at L, to prevent it from floating in the water of the cistern.

ENGRAVING AND DESCRIPTION OF VOLTAIC SERIES, COMBINING THE ADVANTAGES OF THE TROUGH OF CRUICKSHANK WITH THOSE OF THE DEFLAGRATOR.

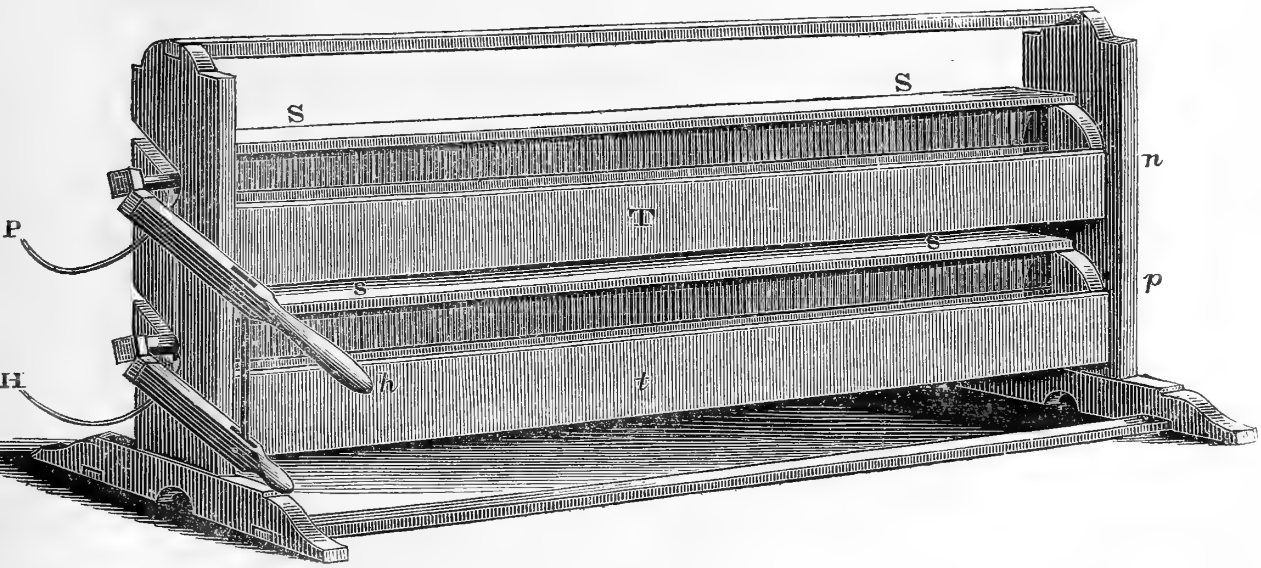
Fig. 1.



Galvanic Deflagrator of one hundred pairs, of fourteen inches by eight.

Fig. 1 represents a voltaic series, upon the plan of the trough of Cruickshank, associated with another trough destitute of plates, and of a capacity sufficient to hold all the acid necessary for an ample charge. The trough containing the series is joined to the other lengthwise, edge to edge, so that when the sides of the one are vertical, those of the other must be horizontal. The advantage of this arrangement is, that by a partial revolution of the two troughs, thus united, upon pivots which support them at the ends, any fluid which may be in one trough must flow into the other; and, reversing the movement, must flow back again. The galvanic series being placed in one of the troughs, the acid in the other, by a movement such as above described, the plates may all be instantaneously subjected to the acid, or relieved from it. The pivots are made of iron, coated with brass or copper, as less liable to oxidizement. A metallic communication is made between the coating of the pivots, and the galvanic series within. In order to produce a connexion between one recipient of this description and another, it is only necessary to allow a pivot of each trough to revolve on one of the two ends of a strap of sheet copper. To connect with the termination of the series, the leaden rods, to which are soldered the vices, or spring forceps, for holding the substances to be exposed to the deflagrating power, one end of each of the lead rods is soldered to a piece of sheet copper. The pieces of copper, thus soldered to the lead rods, are then to be placed under the pivots, which are of course to be connected with the termination of the series. The last mentioned connexion is conveniently made by means of straps of copper, severally soldered to the pivots and the poles of the series, and screwed together by a hand-vice. Each pair consists of a copper and a zinc plate, soldered together at the upper edge, where the copper is made to embrace the edge of the zinc. The three remaining edges are made to enter a groove in the wood, being secured therein by cement. For each inch in the length of the trough there are three pairs. In the series represented by Fig. 1, there are seven hundred pairs of seven inches by three; in that represented by Fig. 2, one hundred pairs of fourteen inches by eight. The latter will deflagrate wires too large to be ignited by the other, but is less powerful in producing a jet of flame between the charcoal points, or in giving a shock.

Fig. 2.



Galvanic Deflagrator of seven hundred pairs, of seven inches by three.

Fig. 2, on the foregoing page, represents a series which comprises two Cruickshank deflagrators, so constructed as to co-operate in one circuit by an adequate communication between their poles, and being so associated with a lever, as to be made, by means of it, to revolve simultaneously. They may be made to act either collaterally, as a series of 350 pairs, or consecutively, as 700. As the plates are seven inches by three, when used collaterally, they are equivalent to 350 plates of seven inches by six.

COMBUSTION OF PHOSPHORUS IN NITROUS OXIDE GAS.

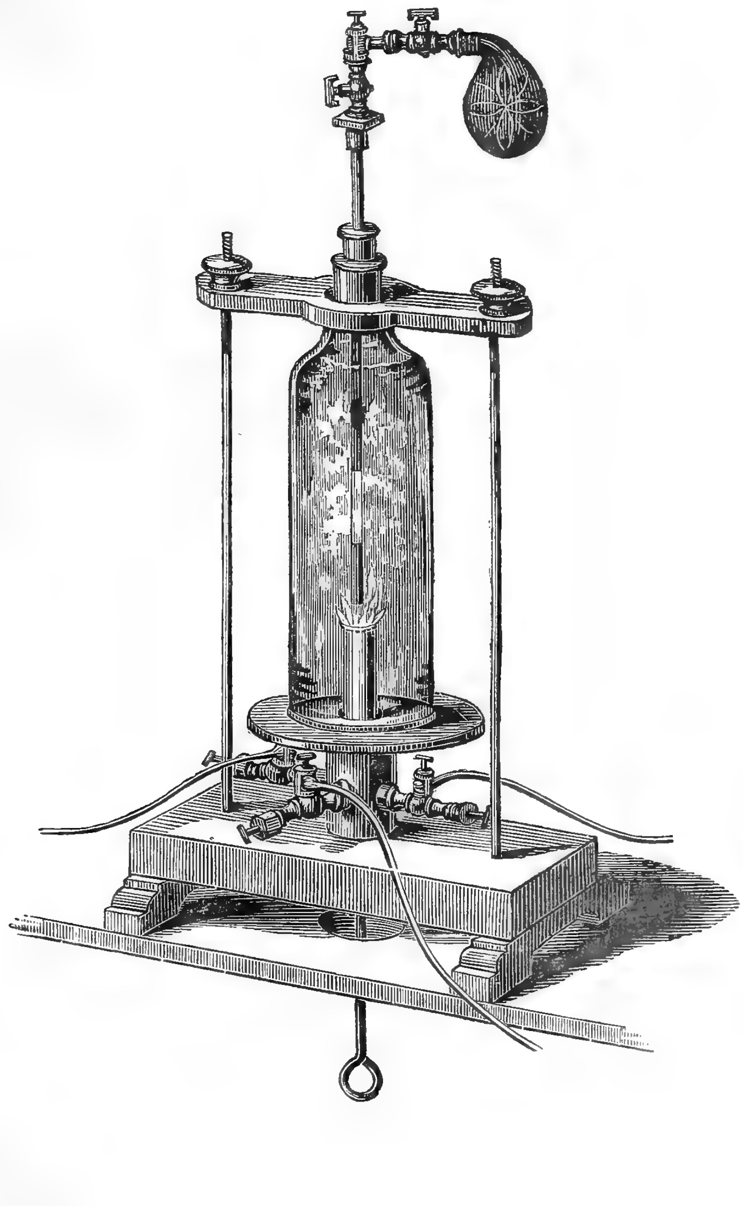
There is a striking backwardness in the oxides of nitrogen to part with their oxygen to phosphorus, until it be intensely ignited, either by an incandescent iron, or by the access of uncombined oxygen.

This characteristic in the case of nitrous oxide, may be illustrated by means of an apparatus like that employed for the combustion of phosphorus in oxygen* with a tall cylindrical receiver, and a tube descending through the neck, and along the axis of the receiver, terminating in a capillary orifice over the cup for holding the phosphorus. The upper end of the tube, outside the receiver, is furnished with a cock, to which a gum-elastic bag inflated with oxygen is attached.

Under these circumstances, the receiver having been exhausted, and filled with nitrous oxide; phosphorus, previously placed within the cup, may be melted without taking fire. But as soon as the cock communicating with the bag of oxygen is opened, an intense combustion ensues; since the oxygen, emitted in a jet from the capillary orifice of the tube, reaching the melted phosphorus excites it into an active combustion, which the nitrous oxide afterwards sustains with great energy.

* See article on Forcing Air Pump, page 388.

COMBUSTION OF PHOSPHORUS IN NITROUS OXIDE.



ARTICLE XXVI.

Notes and Diagrams, illustrative of the Directions of the Forces acting at and near the surface of the Earth, in different parts of the Brunswick Tornado of June 19*th* 1835. *By A. D. Bache, Professor of Natural Philosophy and Chemistry in the University of Pennsylvania; one of the Secretaries of the American Philosophical Society. Read April* 2*d* 1836.

In company with my friend, Mr Espy, I visited, in the early part of July last, the scene of the destructive tornado of June 19th, the ravages of which had been most severely felt in New Brunswick, New Jersey, and its vicinity; the effects extending about seven and a half miles to the west, and ten to the east of that place. The idea of illustrating these effects by the aid of instrumental means, first occurred to me after hearing an interesting account by professor Johnson, before the Academy of Natural Sciences of this city, of an examination made by professor Henry and himself of the position of materials carried by the storm from the city of Brunswick, and deposited in a field on the opposite bank of the river Raritan.

The regularity in the general arrangement of these materials gave me the hope that further facts of interest might be brought to light by an examination of the country along the path, and fully established, as well as clearly represented to the eye, by diagrams laid down from actual measurement.

To this point I devoted exclusive attention during the limited time which a very brief recess from duty at the University afforded me. Mr Espy collected at the same time the accounts of those who had witnessed the phenomenon, examined closely the general circumstances, and is equally concerned with myself in any claim to novelty in the results about to be submitted. As he will embody the deductions from the information collected and from the general observations which we made, I do not propose to go into them further than is necessary to make my results intelligible.

The accompanying diagrams, Plates XXIII. XXIV., represent different portions of the track of the storm, from the point at which its effects were first felt in any considerable degree, to a point about a mile east from Brunswick, where I was reluctantly obliged to close my observations.

They were obtained by means which, though rough, are abundantly exact for such a purpose, namely, by measuring the angles to be taken, by the compass, and by pacing the short distances to be estimated.

Such an examination being made of the track of the tornado through a wood, or in any other suitable case, the directions of the acting forces are determined, and thus is ascertained whether they correspond to the effect of a whirl at and near the surface of the ground, as is generally assumed, or to that of a rushing wind, or, as most fully appears, to that of a mighty column of rarefied air in motion.

Although the action of the storm on buildings affords many interesting facts in regard to the phenomenon, and in one case, an effect of great interest was thus first pointed out; yet, as we expected, the most satisfactory evidences of the directions of the forces occur, generally, in open woods, and in the plantations near buildings.

It may seem superfluous to a reader accustomed to observation to say that entire regularity is not to be looked for in the effects to be brought before him. I have, however, thought it best to remark briefly upon some of the causes which might be expected to produce considerable irregularities, in the positions of trees overthrown, or broken, by the storm.

The soil of the part of New Jersey through which this storm passed is a red clay (from the red shale), and deficient in strength. The trees growing upon it extend their roots very far horizontally, while they penetrate but a short distance below the surface. They are therefore readily uprooted, and in the overthrow carry a considerable extent of soil with them.

If the forces acting during the whole period that the trees were within the sphere of action of the storm, be supposed of equal intensity but varying direction, then the trees extending their roots unequally in different directions, will oppose unequal resistances in those directions, and two trees side by side may be thrown different ways. Several trees presenting thus a want of conformity of direction, would induce, at first view the idea of a total want of regularity calculated to baffle observation. If the forces vary in intensity as well as in direction, this difficulty will be increased. Again, the circumstances of the proximity of other trees may not only influence the direction in which a tree will fall, after its motion has commenced, but the very direction in which the force producing its fall may act. And these remarks apply in even greater force to the case in which trees are broken, instead of being overthrown.

The unequal strength of parts of a building, and its protection by adjacent buildings must produce difficulties of a similar kind; while in the trees near to houses we should look for even more irregularities of direction, than in those in an open wood.

These remarks, it will be seen, are not intended to set aside any cases which may appear inapplicable to a general conclusion, but merely to guard against unreasonable requirements.

Of the diagrams, figures 1, 4, 5 and 7, are drawn to the same scale; the scales of figures 3 and 6 are attached to them respectively; and figure 2 is not drawn to a scale.

The directions of the trunks of the trees are represented in all but figure 1 by arrows. In order to make these directions appear distinctly, these arrows are out of proportion to the horizontal distances between the trees. This causes the tops of trees to appear very near, which, in many cases, were not so.

The first point to which we traced the action of the storm, was near the farm of Mr M. S. Garretson, about seven miles, a little south of west, from New Brunswick. It crossed the Millstone river, and the

Trenton and Brunswick canal, about half a mile to the west of Mr Garretson's dwelling, and its track was between this house and a barn about sixty yards from it. A small portion of a light fence and some other matters were carried across the road upon which the house fronts, and a part of the trees in an orchard thrown down. Neither the barn nor dwellinghouse was injured, and the action was described as that of a strong wind of limited breadth. In the orchard the trees to the south of the path of the storm were thrown northwardly and those to the north southwardly. Passing on to the east, the next effect was seen in overthrowing a large cherry tree, and carrying off the south-west corner of the thatched roof of a small saw-mill. The most violent action, however, at this place was upon a wood nearly east from the dwellinghouse, and is shown in the sketch figure 1, Plate XXIII. This is, perhaps, the most hasty of all the determinations which I made, as the interest which attached to the effects wanted the force of novelty: they being similar to those referred to, as observed by professors Henry and Johnson. The ground represented in the diagram is irregular, consisting of a hill, the sides of which are covered by wood; the hill being cut by a ravine which was apparently near the northern border of the storm, or of that part in which the trees were thrown in the direction of its course. The wood was of young hickory and black oaks without undergrowth, but even here some irregularities were seen. The spiral growth of a few of the trees had led the proprietor of the farm to think, and speak, of the whole effects as produced by a whirlwind. He pointed out those cases, which were, obviously, seen to have resulted from the cause which I have just assigned. It will be observed in the figure that of nine trees there represented, the two on the north side of the storm fell southward and eastward, one, *g*, points out its direction nearly, and five of the six of the south side are directed between N. 10° E., and E. 40° N. The breadth of the storm was here about 200 yards, and its direction about that of the line A B.

We next repaired to a point where the destruction was reported to have been considerable, namely, to the farm of Mr D. Polhemus, between two and three miles E. 17° N. from Mr Garretson's. Here a very curious fact was developed, which I have attempted to represent in the sketch and ground plan figure 2, Plate XXIII. The building or shed attached to a large frame barn, and on the southern side of it, was moved during one part of the phenomenon to the west of north, and subsequently to the eastward. The posts (see b, figure 2) slipped from the stones, a, which supported them, when the building was first acted upon by the storm, and moving northward and westward ploughed a furrow, c, in the soft surface of the ground, heaping up the manure, d, before them. Afterwards, being moved eastwardly, they formed another furrow, e, and a heap of manure, f, remaining in the position, b, when they were pointed out to us. As the first direction is nearly at right angles to that of the motion of the storm, the building being to the south of its axis, the conclusion is irresistible that there was, on the approach of the storm, a tendency to motion *towards* it. The second furrow shows a motion towards the receding storm. Why this building moved but in two directions will appear from the protection afforded to the north east by a large barn, the strength of which enabled it to bear the tendency towards the moving meteor, without much injury. In figure 3, D is the shed, C the barn, and FG the probable direction of the storm, the probable axis nearly coinciding with that line. It is believed that the relative positions of the buildings there shown, are nearly correct; no particular pains were, however, taken on this score, a survey of the orchard to the east of the house being the main object.

Of the trees in this orchard, figure 3, more than two-thirds suffered; being generally torn up by the roots. Of these there are two lying actually west of north, and seven thrown to the north of north east; while the greatest amount of devastation is in the direction of the meteor, which passed over the western part of the orchard, the inclination of its path being about 10° N of E. It is remarkable that some small trees, as n and o, were left standing, and were not much broken. Some large trees, as between s and g′, were also left. The former ones had probably sufficient flexibility to give way to the action of the storm without breaking; c′, b′, a′, f′ and z were probably uprooted on the approach of the storm. The tree y presents a curious case: it is broken into three parts, the middle one lies north, and the two exterior ones are separated from it to the eastward and westward. It will be observed that the trees lying perpendicularly to the track of the storm, are not those furthest from the centre of that track.

While the trees on the southern edge of the storm were thrown generally northward and eastward, the few which were on the north side, were thrown to the southward. Thus at i′ is shown a large black cherry tree, uprooted and lying nearly parallel to the side of the house A, while at k′ and l′ are groups of willows, the limbs of which were broken off, and thrown to the southward and eastward. There were no trees in the meadow to the north of the orchard and east of the group k′.

We were told by Mr Polhemus that the orchard of a neighbour to the west of him had been prostrated, but did not consider it advisable to return upon that point, determining rather to follow the track of the storm towards Brunswick. The general direction of Brunswick from Mr Polhemus's house is E 10° N.

We explored the wood belonging to Mr Polhemus, and eastward from his dwelling, where the marks of the tornado were next to be seen. As, however, nothing of special interest was developed, I have not thought it necessary to copy the drawing made from my notes. Passing through this wood, the track was marked through fields of grain and orchards in which the trees were uprooted, and near buildings which suffered more or less from its action.

The next point of interest occurred where we distinctly made out that the meteor did not maintain its position at the surface of the ground; a fact which has before been observed in regard to other tornadoes. After a slight damage upon the edges of a thick wood of black oak trees, the marks of destruction were not seen until traced upon a ploughed field, to the east of the wood, in which there were a few trees. These were uprooted, and the moist earth from the surface of the field was thrown against the trees of an adjacent wood.

The next diagram, figure 4, represents a very remarkable case, establishing conclusively the direction of the forces already pointed out in figure 2, but in a case less complicated than the former.

In a tolerably open wood, we lost all traces of the storm, but pursuing a general easterly direction, came upon a part of its track where the trees were broken near the top. A little further on they were broken nearer to the trunk, and at last uprooted. A survey of the exterior of a circular space around which the trees were overthrown, gave the accompanying representation, figure 4. The round was traced by the directions of the trees; that is, having set out at one point, I arrived at it again, by following the indications afforded by the directions of the trees. In the mean time Mr Espy explored the interior of the round, and pointed out to me a space where the tops of the trees were lying together. The evidence of a rush towards a central space is thus conclusive.

To generalize the results of this diagram, it will be seen, that with a few exceptions to be remarked upon directly, all the trees on the southern border of the circular space A, are thrown northward; those to the north southward; to the east westward, and to the west eastward.

These exceptions are probably to be referred, generally, to the forward motion of the spout. Thus, while c is thrown to the west of north, a tree beside it, and many like p to the south of it, were carried in the general direction of the moving column. The same is true of trees to the north of g and h. In selecting the trees to be noted, I took care to put down cases which seemed anomalous, lest something of consequence should escape observation. The irregular positions of the tops of trees at i, seem to be sufficiently explained by their interference in falling. The tree g may have had its top carried northward in falling, and lies almost directly opposed to the directions of trees to the north of it; these trees being bent permanently, but not broken. Pursuing the track of the storm along B C, the trees were thrown in its general direction.

Passing forward to the east, we lost the traces of the storm, and when they appeared again, the circumstances seen in approaching figure 4 were repeated. Figure 5 represents the recurrence of the effects produced by the descending of the column to the ground. I did not think it necessary to go round, with the compass, that part of the circle which is turned in the general direction of the motion of the spout, but merely the other portion which presents the curious circumstance of trees thrown in a general direction opposed to that of the motion, proving conclusively that a rushing wind from the westward will not explain the effects. The fatigue incident to the previous work made me very willing to cut off all that seemed of doubtful utility.

The next position surveyed, was at and around the dwelling of Mr David Dunn. The destruction here was terrible indeed. The dwellinghouse had been unroofed, and otherwise severely injured. A large barn and stable had been torn down, the outhouses prostrated, and all the trees around the dwelling uprooted or broken to pieces. The storm had passed from an adjacent wood, about one-sixteenth of a mile to the west. All this destruction had been accomplished and an entire calm taken place, in the time that Mr Dunn ran from the front to the back door of his dwelling, a distance of about thirty feet. This excessive rapidity of motion was no doubt one of the causes why lives were not lost, in vain attempts to escape from the effects of the storm.

Mr Dunn received us with great kindness, and gave every information in his power without expressing weariness at our curiosity. Indeed it is but justice to say here that we met with uniform courtesy and kindness, along the whole route of our inquiry, and experienced no case where those whom we addressed were unwilling even to leave their work, to point out to us matters worthy of attention. For this attention we beg leave thus publicly to return our thanks.

A general glance at sketch figure 6 will serve to show that the trees near the house were thrown inwards. No case occurs in which the trees are thrown outwards from the house. Many, however, further to the north and east of the house, and which are not represented in the sketch, were carried in the direction of the storm. A closer examination will serve to show several interesting particulars.

Of twelve trees in the row A B, south and west from the dwelling, all but three were injured, and generally uprooted. The three not injured were young black cherry trees, two were of "medium size," and the other quite small. Six of the trees were thrown between N. $4\frac{1}{2}^\circ$ W., and N. W., or *towards the approaching spout*. Three were thrown towards the house, namely, the one nearest to the house, and two furthest from it: all these are large trees. Of the trees around the house, all those uprooted or broken, except *q* and *k*, point towards the house, and these were evidently caught by the trees to the west of them. *s'* presents a curious case: the tree was broken off, and the fragment carried towards the west; then, by a subsequent force, laid in the position *s'*, E $7\frac{1}{2}^\circ$ S. The tops of *m*, *n* and *w* were lying together in a heap, and the limbs from the trees in this group, together with palings from a fence to the west of the house, and fragments of the outhouse, C, were strewed at *x*. *u* and *t* have received their direction probably from the onward motion of the spout, which heaped an immense mass of rubbish against the west side of the house, breaking it in, and destroying nearly every article of furniture in the south-west room. The house, and the area just described to the north of it, seem to have been the scene of this inward rush. The facts to prove that it was also an upward one, will be stated by Mr Espy. The trees in a field to the north of the house, and beyond *u*, *t*, *s*, *o*, were carried eastward in the general direction of the storm; and in a field still further north, the rafters from the roof of the dwelling A were found.

Two rows of trees extended from the south side of the house to the road. These do not appear to have suffered as much as the row to the west of them. In the nearest position of the spout, they were in part protected by the house. The trees which were uprooted lie in directions extending over the sector between N. 15° W. and N. 45° E.; much the greater number of trees being thrown between north and north east.

A tree at *d'* was thrown against a small porch to the north of east of it.

As the destruction to the eastward of this house renders it improbable that the axis of the spout did not touch the ground there, it seems to me that this inward rush indicates that the spout had its velocity *momentarily* checked at this point.

On the following day we examined a wood to the east of Brunswick and on the opposite side of the river Raritan. This wood is to the east of the position examined by professors Henry and Johnson, from which the debris inspected by them had been removed.

The case here presented was so complex, that I doubt much if we could have unravelled it without previous preparation. The irregularities encountered on the southern edge, see diagram figure 7, detained me so long, that I was only able generally to sketch the northern borders, the directions of the trees being, however, still taken with the compass. The inward direction of the forces is here well made out, notwithstanding the confusion produced by the subsequent forward rush of air. While I was engaged in obtaining materials for this sketch, Mr Espy penetrated further west into the wood and beyond it. He states that the marks on the trees indicate a downward motion of the spout at this place, more obscurely made out than in the other cases before described. The nature of the ground to the west of the wood was unfavourable to an exact determination of this point, but it is probable that the spout was raised, for a short distance, above the surface of the ground.

As far as the examination of the different diagrams has shown, I think it entirely made out that there was a rush of air, in all directions, at the surface of the ground, towards the moving meteor; this rush of course carrying objects with it. That the meteor did not always extend to the surface of the ground, and when at the surface did not move uniformly either in velocity or in direction.

In figure 1 there is no motion towards the approaching meteor exhibited; and this appears generally to have been the case along its track when moving uniformly and reaching to the surface of the ground. The reason of this readily appears, for the air in front of it would hardly be in motion, the trees carried by it hardly bent, before the second and more violent action would prostrate them in the general direction of the motion of the meteor.

Figures 2 and 3 exhibit cases of this motion in both directions, towards the approaching and towards the receding meteor. But there is no evidence here that the spout was not moving along the surface. In the case of figure 2, the motions were registered by the effects upon the ground, and the easily uprooted trees shown in figure 3, fell in directions, with one exception, between 10° W. of N. and 3° N. of E.: the meteor moving about 8° N. of E., and to the north of the orchard containing the trees.

The disappearance of the track of the storm is first satisfactorily made out in the remarks subsequent to those upon figure 3. The effect of a second case of the sort is represented in figure 4, where around a circular space, in which the tops of the trees were found lying together, is a ring in which the trees generally point to the central space. At the outlet, where the storm moved on its track, the trees are found in the ordinary directions, and the same is true to the eastward of the place in which this descent of the spout occurred.

A second case of the same kind is represented in figure 5. At Mr David Dunn's, the evidence is against such a descent having taken place at the dwellinghouse, as shown by the row of trees to the south and west of the house, see figure 6, and by the fence, trees and shrubs of the garden to the west of the house. Yet the dwelling appears as a centre, towards which objects to the north and east of it were thrown. To account for this I have supposed a momentary, and the evidence shows that it was merely momentary, pause or check in the velocity of the meteor. Such pauses were represented to us by many spectators to have taken place, and sometimes in cases where they could hardly have been deceived. In figure 7 is shown a case in which it is doubtful whether the effects are those of a check of velocity, or of a descent of the spout; most probably both took place.

These effects all indicate a moving column of rarefied air, without any whirling motion at or near the surface of the ground.

References to the Diagrams on Plate XXIII.

Figure 1.

Wood of Mr M. S. Garretson.

a. Tree uprooted,* N. 20° E.
b. Broken off, lies N. 10° E.
c. Hickory torn up by roots with a sapling alongside, N. 38° E.
d. Top of a black oak blown off, carried to E. 40° N.
e. Hickory broken off about two feet above the root, lies E. 1° N.
f. Black oak broken off at the root, E. 41° N.
g. E. 15° N., about thirty yards from the north edge of the storm.
h. The south east corner of Mr Garretson's house bears W. 3° S. from this point.
i. A sapling bent over and kept in place by other trees, E. 30° S.
k. A sapling bent to E. 36° S.

Figure 2.

Outhouse of Mr D. Polhemus.—Ground Plan.

a. A flat stone, on which the post b originally stood.
b. Present position of the foot of the post.
c. Groove made in earth to northward of a by the post.
d. A mound of manure heaped up at the end of the groove c.
e. A second groove north of east in direction.
f. A mound heaped up by the post b two feet high.

Figure 3.

Grounds of Mr D. Polhemus.

A. Dwellinghouse of Mr Polhemus, slightly injured.
B. Outhouses not injured.
C. Barn, shingles torn off, not many in number.
D. Shed shown in figure 2.
E. Open work corn crib, not injured.
a. N. 12° E. Uprooted.†
b. Tree uprooted, too crooked to determine its direction.
c. N. 6° E.
d. N. 27½° E.
e. E. 20° N.
f. Tree standing near the fence.
g. E. 6° N.
h. E. 3° N.
i. E. 3½° N.
k. E. 18½° S.
l. E. 25° N.
m. E. 18° N. Tolerably straight. Shingles from barn found at the foot of m. Southeast angle of the barn bears W. 30° S.
n. Tree standing.
o. Low tree standing: small.
p. N. 32° E.
q. Broken, not uprooted.
r. N. 27° E. Dead: bushy.
s. Standing. High and stout.
u. N. 24° E.
v. Plum tree near, standing.
x. N. 5° E.
z. N. 9° W. Small, firmly rooted in north side.
y. Thick and bushy: broken off into three parts, the smallest of which points west of north, the next north, and the largest east of north; the bark is stripped off below the fracture.
a'. N. 4° E.
b'. Same general direction as a'.
c'. N. 2½° E. Small roots.
d'. E. 22° N. Very large roots.
e'. N. 10° E.
f'. N. 10° W. A small tree near this, in the same row is untouched.
g'. E. 35° N.
h'. E. 3° N. Three trees at the south end of the row f' g' are standing.
i'. A very large black cherry tree, uprooted, and lying nearly parallel to the house.
k' l'. groups of willows, the limbs and branches of which are torn off, and thrown to southward and eastward.

Figure 4.

A wood.

a. N. 40° E. Uprooted.
b. N. 35° E. Several in the same general direction.
c. N. 29° W. The top of a tree has fallen on c and nearly at right angles to it.
d. W. 12° N. Uprooted.
e. W. 42½° N.
f. W. 13° N.
g. W. 4° N. It lies N. 15° W. from c, and about one-eighth of a mile from it.
h. S. 23° W. One of the last trees near the edge.
i. Top blown E. 36° N., large end foremost. Another top at right angles.
k. Top blown off E. 0½° S.
l. E. 7½° N. A tree near l is broken off and top lying to west, obviously could not go to eastward on account of the other trees.
m. N. 23° E.
n. N. 15° W. Many large and small trees, not varying in direction 5° from the direction in which this has fallen.
o. Is the same as a. Being at once the point of departure and of termination. b was also examined and identified.

* The trees are uprooted unless the contrary is stated, or shown in the figure.
† The directions of the arrows indicate those of the trunks of the trees.

References to the Diagrams on Plate XXIV.

Figure 5.

A wood.

a. E. 35° S. Tall hickory broken off about fifteen feet from the root.
b. S. Also broken.
c. S. 31½° W.*
d. W. 9° N. Uprooted. A tree near to d is broken off and carried in the same general direction.
e. Broken off and carried W. 18° N. A tree near to this and west of north of it, carried in the same general direction.
f. A large rotten oak broken off, lying W. 36° N. Its trunk at the base, fifteen feet from the fracture, measures six and a half feet in circumference.
g. A broken tree lying over f and nearly at right angles to it.

Figure 6.

Dwelling and grounds of Mr David Dunn.

a. N. 40° E. A cherry tree. The west corner of the house is about one hundred feet off, and lies to N. 42½° E.
b. N. 20° W. A cherry tree uprooted.
c. Cherry tree of medium size, unbroken.
d. N. 22° W. A large cherry tree uprooted.
e. N. 19° W. Uprooted.
f. Small cherry tree standing.
g. Large cherry tree N. 4½° W.
h. Cherry tree of medium size, unhurt.
i. N. 10° W.
k. Black cherry tree N. 13½° W.
l. N. 23½° E.
m. Largest cherry tree in the row, N. 10½ E.
n. Large pear tree.
o. Broken off and cut since the storm.
p. A small tree standing. A tree on the opposite side of the road is broken off and the broken part lies to the northward.
q. A large black cherry tree lies N. 15° W.
r. Not taken.
s. Broken seven feet from the ground, and has fallen against t.
t. Not taken.
u. A large black cherry tree N. 18° E.
v. E. 30° N. Large black cherry tree, torn up and thrown from its bed.
w. N. 40° E. Black cherry tree.
x. N. 3° E. Smaller cherry tree.
y. N. 18½ E. Largest size.
z. Broken to north east.
y′. Standing.
z′. Broken.
a. N. 3° E. Very large black cherry tree.
b. Small tree not injured.
c. Larger than *b* not injured. Small.
d. Uprooted N. 45° E.
e. Small.
f. Medium size cherry tree. Not broken.
g. Broken limbs to east. A black walnut (?) tree.
h. Cherry tree broken.
i. Pear tree uprooted.
k. N. of house. W. 4° S. Small fruit tree fallen against *l*.
l. Stripped of leaves.
m. Pear tree uprooted, points, as shown in the figure, towards the house.
n. Ditto.
o. *p*. Broken fruit trees. Small.
q. Broken off and lying against *r*.
s′ Is the position of the broken part of *s*. It lies E. 7½° S.
t. Large pear tree, pointing as shown in figure.
u. Points to about ten feet east of the wash house B. It is a broken apple tree.
v. Broken pear tree, coated with dust on the north west side.
w. Large cherry tree broken off E. 27½° S. Its top lies with those of *m* and *n*.
x. A pear tree. Broken.
y. A black cherry tree, uprooted and thrown against *z*. Lies in the line *y z a′*.
z. Black cherry tree, dirt on the north east side of it. Broken on that side, its limbs lie parallel to the house.
C, D. Two outhouses to east and west of *z*. The timbers of the eastern outhouse C lie in the mass *b′*, which contains the tops of trees, &c. The windows of D are broken on the east, one on the west side is forced in. Clap-boards are off in part near the ground on the north side.
b′. A heap of rubbish left by the storm. Tops of trees *k*, *l*, *m*, &c., beams from C, &c.
c′. A tree lying as shown in the figure.
d′. To S. of house. A small tree broken and thrown against the porch H.
F. A fence to the west of the house prostrate, and in part carried against and into the west side of the house. All the trees and shrubs which were in this garden are prostrate or broken.

Figure 7.

A wood to the east of New Brunswick.

b. N. 26° W. Two oaks close together, uprooted. Trees to N. 26° W. of *b* lie in the same general direction.
c. E. 9° N. Trees near c and to west of b lie, some directed as c, others as b.
e. E. 36° N. A small oak, which may have been deflected by the trees against which it has fallen.
f. Three trees, smallest N. 38½° E. The largest has possibly been deflected by the trees against which it has fallen : it rests N. 18½° E. One to the west of the other two is rotten; it lies N. 3½° W. Smallest and largest not wholly uprooted.
g. N. 16½ E. Uprooted. A tree to the south of this inclines to the east.
h. E. 40° N.
i. W. 18° N.
i′. Two small trees uprooted, lying under i, N. 3° E.
k. Broken. Its top lies N. 10½° E. from the trunk. Crooked.
l. N. 6° E. The top of an oak. Broken off.
m. Top off. E. 32° N.
p. N. 16° W. Three oaks uprooted.
q. N. 30° E.
q′. To N. and E. from q. Broken, N. 35° E.
r. Two oaks uprooted, E. 36° N.
s. N. 23½° E.
t. N. 32½° E. Several others not 10° from this direction.
v. A broken oak, N. 44° E.
w. Top broken off and carried to north east. Direction of the stem of top N. 20° E.
x. N. 26° E.
y. N. 10° E.
z. Top carried to N. 39° W. Some trees near, lie to N. 40° E.
a. Lies S. 2½° E. Another, near it, is in the same general direction.
b. Nearly south. A rotten stump.
c. A sound tree broken to S. 35° W.
d. Uprooted to S. 36° W. Many like this to the east of it.
e. S. 28° W.
f. S. 14° W. This tree is north of the point a.
g. S. 12° W.
h. Very nearly S. 3° E.
i. S. 6½° W.

* The trees to the directions of which the angles refer, unless when the contrary is stated, were uprooted.

ARTICLE XXVII.

Deductions from Observations made, and Facts collected on the path of the Brunswick Spout of June 19th, 1835. By James P. Espy, Member of the American Philosophical Society. Read April 15th, 1836.

From the evidence which I collected during five days which I spent on the Brunswick spout, the following important facts are clearly established.

The spout was suddenly formed about seven and a half miles west of New Brunswick, and terminated as suddenly at Amboy, about seventeen and a half miles from where it began. It travelled a little east of north with a very moderate velocity, probably not more than twenty-five or thirty miles an hour. It appeared to all persons, in whatever direction it was viewed, in the shape of an inverted cone of very dark cloud or smoke, reaching from a dark cloud above down to the earth.

It prostrated nearly every thing in its path, which was from two hundred to four hundred yards wide; the trees on the north of the central line being thrown with their tops towards the south east, and those on the south of this line with their tops towards the north east; while those in the central line itself were thrown nearly towards the east, or in the direction of the spout: not one instance being found of the trees being thrown with their tops outwards.

It unroofed the houses, prostrating many of their walls outwards as if by explosion, and tearing up the floors of some whose walls were left standing; and not unfrequently, it lifted frame buildings entire from their foundation.

It carried the joists and rafters in some instances to a considerable height and threw them down on the north side of its path, four hundred yards from the house from which they were taken, almost at right angles to its course, and exactly opposite to the course which the wind must have blown at the ground in the yard, as manifested by the direction in which the trees were lying.

It carried up shingles, boards, hats, books, and branches and leaves of trees, and threw them down on the north side of the spout in a band of several miles wide, terminating on the north east end of Staten Island and fifteen miles from Amboy, where the spout ceased to reach the earth, and twenty-five miles from New Brunswick.

At the time when these materials fell, there fell with them a violent shower of hail and rain, the hail however being confined to a few miles in the middle of the band where the heaviest part of the shingles and boards fell.

On each side of this band, particularly on the north, there fell a copious shower of rain, mingled with shingles; and even beyond the borders of the rain, on the north east, small branches and leaves of trees fell in New York Bay, and in North River opposite to the city of New York.

There was no rain nor hail on the path of the spout, nor on the south side of it; it began about a mile on the north side, increasing in quantity to the middle of the band where the hail was, and then gradually diminishing again as it approached the northern and eastern boundary.

The spout lasted only for a few seconds in a place, and was immediately before and after nearly calm, and its effects were hardly felt a few hundred yards off to either side. The noise which accompanied it was every where described as very alarming, not like any thing heard before, more like the rumbling of a great many carriages than any thing else, or, as one man expressed himself, like an earthquake in the air. In Staten Island, as to the length of time this noise was heard previous to the commencement of the hail and rain, the evidence varies from fifteen minutes to an hour, and as to the length of time the shower was falling, it varies from eight minutes to thirty or forty.

Though there was no rain in the path of the spout, the cloud or mist of which it was composed must have been very humid, as the grave stones at Piscataway were covered on the west side with a coat of mud, and in many places the grass and leaves which lodged in masses on the west side of trees which were left standing were clotted together with mud, as if they had been drifted there by an inundation, and several persons that were caught in the spout were entirely covered with mud, so that they could not be known by their friends. There were some lightning and thunder attending the meteor, but not much unless the continual rumbling or roar was produced by it, which is not very likely, as a great many who heard the rumbling did not even see lightning.

The wind, probably in the whole length of the spout, certainly in many places, began to blow on the northern half of the spout from the N. E., and on the southern half of the spout from the S. E.; for materials were found which had been moved in that direction first, and afterwards carried back even beyond their original position by the hinder part of the spout, which appears in all cases to have been the strongest. As a proof of this, several places were found where the weak and rotten trees were thrown down by the van of the spout, with the tops of those on the northern side towards the S. W., and the tops of those on the southern side towards the N. W.; while the stronger trees which resisted the first shock were afterwards prostrated by the rear of the spout. And in every case where trees were found lying across each other, which to a careless observer might have indicated a whirlwind of confusion, the most perfect regularity was manifested; the strongest trees lying on top, and with their tops pointing inwards and forwards, as mentioned before.

Besides, four different places were found where the tops of all the trees in a circular space, equal in diameter to the breadth of the spout, were thrown inwards towards one common centre. In the middle of one of these stood a large frame house, which had its roof carried off. The walls of the upper story, both on the north and south side, were cracked; and in one crack was thrust a lady's pocket handkerchief, and in the other a sheet, taken up from a bed in the room, and the cracks closed when they were carried partly through. All the windows in the house were broken, and much of the glass was lying on the outside of the house. The owner of the house is sure all this was done in a second or two of time, and he assured me that the next moment it was as still as death, not enough of air to move the leaves of the trees, which were prostrated all round his house with their tops against his very door.

In this case the van of the spout appears to have been as strong as the rear, for several out-houses to the east of the dwelling mansion were prostrated, having many of their heaviest materials carried some distance towards the west. Perhaps indeed I was too hasty in drawing the conclusion that the rear of the spout was stronger than the van, from the circumstance that the trees were generally thrown down in the direction of the spout; for if the forces had been *equal*, they might have generally fallen in this direction, from the momentum they would have in this direction in straightening themselves, by their elasticity, at the moment the van passed and the rear came upon them. Notwithstanding, as the wind on that day was from the S. W., this circumstance renders it probable that the rear of the spout was the strongest; for it would appear that the force of the wind, whatever it was, should be added to the rear and subducted from the van.

During the fall of the rain and hail in Staten Island, the wind in the borders of the shower blew in all places from the centre of the shower, very strong in the northern part from the south, variable in the middle, and moderate in the south from the north. And the rumbling noise preceded the fall of the rain at least fifteen minutes at Mussero's ferry, on the very north side of the island. As the time of the shower at this place was certainly, from the evidence, after the spout had disappeared, it seems probable that the spout continued in mid air some time after its disappearance at the surface of the earth.

Was this noise caused by the concussion of the materials, the lighter particles of hail which were then just formed being carried up with great swiftness against the heavier, which at that time might be at their greatest elevation or even beginning to descend; or was it produced by electricity? The height of the spout where it lost itself in the cloud, though it probably rose much higher into the cloud itself, was not very certainly made out.

It is probable, however, from comparing several accounts of the distance at which it was seen, and the angular elevation as near as could be ascertained, that the height was about a mile, or, from the very distinct testimony of Mr Cole, a little more.

He was standing four and a half miles east of Amboy, beyond which the spout did not reach. He saw a very black column of cloud, about eight times as high as it was broad, rising in the west; lighter clouds on each side of it were "streaming" towards it with great velocity and joining it, but not crossing it. The upper end of this column was about ten degrees high. The evidence of Mr Hunt, engineer of the boat Napoleon, is almost exactly similar to Mr Cole's. He was about seven miles from New Brunswick, and saw the spout before it reached the town. He thinks, however, that the column was only about three times as high as it was broad. After looking at it some minutes, he could plainly see detached pieces of cloud darting inwards and upwards, joining the upper end of the column and losing themselves there, and in five or six minutes more, when the column reached New Brunswick, the materials which had been seen to fly upwards increased in number, and gave the appearance of a volcano; these materials seemed to him to rise three hundred yards. Now as the spout when first seen by Mr Hunt must have been eight or nine miles distant, its height could hardly have been less than a mile.

On this same day three other spouts occurred, about seventeen miles apart, measuring perpendicular to the line of direction of the Brunswick spout. The one next to the Brunswick spout, seventeen miles north, passed through a village in the neighbourhood of Patterson, New Jersey, about three hours after the passage of the spout at Brunswick. It was accompanied by violent hail and rain on the very path of the spout.

On the same day and afternoon and night, there was a very great rain in the state of New York, commencing at Schenectady, about three P. M., with a roaring of fifteen minutes like a distant cataract: 2·45 inches of rain fell in Albany, wind N., and much more at Lebanon. And during the whole night of the 19th, there was in the neighbourhood of Amboy a violent S. W. wind and very black clouds coming from the N. E., mingled with a bright silvery light, and most vivid lightning without thunder. The wind below changed about daylight to the N. E., and blew violently very cold for some hours, and then again resumed its old course, S. W., on the afternoon of the 20th.

On this same morning, the 20th, a most violent N. E. gale was experienced at Quebec.

Two conclusions, which promise to be of immense value in meteorology, are clearly deducible from the facts here established.

1. *There was an inward motion of the air in all directions towards the centre of the spout below, and upward motion in the middle.**

2. *The hail was formed by the congelation of drops of rain generated at and over the place where the shingles were taken up.*

* The cause of this upward motion in the spout is the great expansion of the air from the evolution of latent caloric, when the vapour in the spout changes to water; the expansion of the air by the liberated caloric being about six times greater than when combined with water in the form of vapour, as has been fully explained in a paper now preparing for insertion in the Transactions of this Society.

ARTICLE XXVIII.

On the Relative Horizontal Intensities of Terrestrial Magnetism at several Places in the United States, with the Investigation of Corrections for Temperature, and Comparisons of the Methods of Oscillation in Full and in Rarefied Air. By A. D. Bache, Professor of Natural Philosophy and Chemistry, and Edward H. Courtenay, Professor of Mathematics, in the University of Pennsylvania. Read May 6th, 1836.

The observations for horizontal intensity which we are about to present to the Society were commenced in the spring of 1834, and have been continued at intervals since that time. The first series was made with the usual apparatus, namely, a needle, suspended by a fibre without torsion, and made to vibrate in a closed box. The second series was obtained by oscillating the needles in rarefied air. These latter observations having proved satisfactory, we should be able to determine the total intensities at the several places of observation, were the dip determined with a sufficient degree of minuteness. While our observations with the ordinary dipping-needle already published by the Society,* show approximately the variations of that element, a minute variation in the angle affects, when the dip is so large, so considerably the total intensity, that we do not feel warranted at present in combining those results with the horizontal forces.

* American Philosophical Society's Transactions, Vol. V., (Part II.) page 209.

In the present state of the experimental part of this branch of science, we are induced to present these observations, not only as showing the horizontal intensities at the different places of observation, but on account of the deductions warranted by the investigation of corrections for temperature, and the comparison afforded between the methods of oscillation in full air, and in a rarefied medium. This latter mode is so great an improvement, that its claims cannot be too strongly urged.

The most numerous observations of the first series above referred to, were made at Philadelphia and West Point. These presented discrepancies which we were entirely at a loss to explain.

The differences, in the time of ten vibrations, as observed on different occasions at the same place, were of an amount entirely beyond what could have resulted from errors of observation, which the method of observing rendered quite small. Pains had been taken, in all cases, to remove magnetic matter which might have affected the results; and in other respects the observations were carefully made.

Some part of the discrepancies might be charged to the errors in the time-pieces used. The observations at West Point were made however, with a chronometer of undoubted reputation, and most of those at Philadelphia, with chronometers of good standing; and the discrepancies could not thus be satisfactorily accounted for.

The magnetic needles used had not changed their magnetism during the series of observations, and were thus shown to be sufficiently hard to retain their charge. It was not probable, therefore, that they would readily change, from day to day, their magnetic state, unless from changes in the earth's magnetism, or from heat. A correction for temperature was ascertained by experiment, and the results show that this correction was accurate. Without it the amount of the differences is very much increased.

It is possible, that in some of the earlier observations in the first series, sufficient care was not taken to allow the needles to attain the temperature of the surrounding medium, a source of error which was guarded against in the later results.

The discrepancies seemed to us to show, either that there was some imperfection in the apparatus, other than those already enumerated, or that the magnetism of the earth really undergoes frequent and considerable changes. This latter point seems to be generally conceded, but we do not think upon sufficient grounds.

Mr Harris,* of Plymouth, had already pointed out the effect of currents of air within the apparatus in which the needle is inclosed, as rendering this method of experiment objectionable. He had proposed to remove this objection by oscillating the needles in a rarefied medium, and had devised an apparatus for this purpose. Mr R. W. Fox had noticed the same defect.† It first occurred to us in full force when observing for the correction for temperature. This source of error was particularly active in the case of the needle of the smallest mass, oscillating rapidly, and, as is usual, in large arcs, at the commencement of the motion. To get rid of this cause of error, we resorted to the method proposed by Mr Harris, and had constructed a stationary, and also a portable apparatus for vibrating in a rarefied medium. The stationary apparatus was intended to investigate the supposed changes of the horizontal intensity from day to day, and the portable apparatus to repeat the observations made in the first series at several different places.

Our expectations of the superior accuracy of observations in a rarefied medium, were not disappointed. We had laid aside our first series of results as unsatisfactory, and now propose to use them only when the observations were very numerous. A comparison of their mean error with that of the series in the rarefied medium, will serve to show, that they have little weight when the number is not very much multiplied, in comparison with the latter.

It was stated that arrangements had been made by Mr Harris for determining the relative intensities at certain places in England, by a needle oscillating in rarefied air; but we believe that our results are the first of this kind which have been offered to the public. The method of vibrations in air continues to be used, and, if our views of its imperfections are correct, the importance of our results is consi-

* W. Snow Harris, in the Trans. of the Royal Society of London, 1831, pp. 67, 68, &c.

† R. W. Fox, in the London and Ed. Philos. Mag., Vol. I., p. 310, &c.

derably beyond what could be claimed for the mere determination of the horizontal intensities at the several places of observation.

These and other circumstances render it imperative upon us to give the observations in detail, and will, we trust, excuse to the Society the length of our memoir.

OF THE INSTRUMENTS.

The needles used in the First Series for horizontal intensities were of the form originally adopted by professor Hansteen, namely, cylinders terminated by cones. They were three in number, and of different masses. These were in turn suspended by one or more fibres of silkworm's thread in a small box which protected them from the air, and at the bottom of which was placed a graduated circle. Two threads were fastened vertically against two small glass windows in the sides of the Box, and in a plane passing through the centre of the divided circle. These threads, when brought into the plane of the magnetic meridian, served to observe the passage of the ends of the needle across this plane. Three levelling screws were attached to the bottom of the box. The method of adjusting for the level of the needle, and of the box, for placing the line of suspension in the direction of the threads, and bringing them into the meridian, and for centring the needle, are too simple to need any particular description. The needles were placed in small stirrups, and were raised, usually, about half an inch above the bottom of the box.

Needle No. 1, the largest, was three inches long, and .22 in diameter in the cylindrical part. It was placed in a brass stirrup, and suspended by two fibres of silkworm's thread. This needle was most steady in its vibrations, and did not lose any appreciable part of its magnetism while in use, though it was softer than No. 3.

No. 2 was of the same material as No. 1. Its length was 2.53 inches, and diameter of the cylinder .22 inches; weighing, with its stirrup, 203 grains. Both of these needles were made at West Point, and they were not highly charged.

The observations made with the latter needle, No. 2, were few in number, and they were neither considered at the time of the observations, nor proved by their agreement with those made with Nos. 1 and 3, to be satisfactory, we have thought it best not to use them in taking our mean. We have placed the description of the needle here, because the correction for temperature was observed, and we are enabled to use the results in their bearing upon the general conclusions in regard to the effect of heat on the intensity of the magnet itself.

No. 3 was of the Hansteen model, 2.43 in length, and .14 inch in diameter, at the cylindric part; weighing, with its pasteboard stirrup, 78 grains. For this needle, we are indebted to our friend, professor Henry, of Princeton, by whom it was made and magnetized, several years since. Its rate is slower than that of either Nos. 1 or 2.

The needles were kept in separate boxes, and when stationary, or carried from place to place, the cases containing them were kept as far as possible from each other, and from iron or steel.

Observations were made at Philadelphia and West Point, with a fourth needle, C of *second series*, but the results were very little accordant. This we attribute to its small mass, and the rapidity of its vibration. So materially was this needle affected by accidental circumstances, that its small correction for temperature not only was masked by them, but was even, apparently, negative under their influence. In a rarefied medium the performance of this needle was very regular and satisfactory.

In the Second Series of observations, upon which we principally rely, three needles were used. The first, A, was a small bar 2.83 inches long, and .22 by .14 of an inch in cross section, the larger dimension being vertical. The weight of the bar, and of its suspending stirrup of wire, was 184 grains. It was suspended by three silk worm threads, and made, when in a medium rarefied to between three and a half and three inches of mercury, three hundred vibrations, between the semi-arcs of four and two degrees. A small black line on a white ground, upon one end of the needle, served to observe its passage over the meridian, when oscillating.

The second needle, B, was No. 3 of the first series. It was placed in a pasteboard stirrup, which made its moment of inertia slightly different from that in the first series. It made about two hundred and fifty vibrations between the semi-arcs of six and two degrees, in a medium rarefied to between three and a half and three inches of mercury.

The third needle, C, was the fourth of the first series. It made, between the semi-arcs of six and two degrees, three hundred vibrations, at the pressure just referred to. The length of this needle was 2.36 inches. The diameter of the cylindrical part .14 of an inch, and the weight of the needle and paper stirrup in which it was hung 72 grains.

The apparatus in which these needles were oscillated, consisted of a small jar, furnished with a brass cap, screwing into a ring cemented around the mouth of the jar. Attached to this cap was a siphon gauge to show the pressure within; a lateral tube, or passage, from the jar, terminated by a screw, served to apply a small syringe for the purpose of exhausting the jar. The tube was closed by a valve of oiled silk, which acted as one of the valves of the air-pump. A metallic stem, passing through a collar of leathers, occupied the centre of the plate; and the needles, being suspended by a hook at the end of this stem, were raised or lowered by means of it, as occasion required. A scale for measuring the arcs of vibration was fastened around the exterior of the jar. The smallness of these arcs rendered minute accuracy in their measurement of no importance.

A jar of the requisite form not being at hand, one of ordinary height in proportion to its diameter, was partly filled with cement, so as to diminish the space within. The height of the part of the jar in which the needle vibrated, was about three and a half inches, and its diameter nearly the same. The needles swung about .6 of an inch from the cement floor. This jar was particularly adapted to needle A.

A thermometer placed within the jar completed this apparatus. The parts being readily detached, the whole was very portable.

METHODS OF OBSERVATION.

In the commencement we adopted the method used by Captain Sabine, and described in the Royal Society's Transactions, London, for 1828. We have subsequently adopted another method, which not only saves much labour, but is, we think, quite as unexceptionable in a theoretical point of view, as the one just referred to. This is, simply, to note the time of beginning and ending of a considerable number of vibrations, with the arcs of vibration at the commencement and end.

In practice, the needle having been made to oscillate, and having arrived at the arc previously fixed upon for beginning the observations, the time of passing the meridian is noted. The oscillations continuing, when the arcs have decreased to the point intended for terminating the experiment, the time of passage is again observed. The interval is the time of making the observed number of oscillations. If it were necessary to count this number without any checks upon the counting, the method would be tedious and liable to mistakes, but this is not the case. If the time of a given number, for example, of ten oscillations has been found approximately, and the time of passage of the needle over the meridian be always observed when the same end is moving in the same direction, there can be no doubt of the number of vibrations corresponding to an observed interval, until the difference between the quotient of the observed interval by a number greater or less by two than the true number of oscillations, is less, than the limit of accuracy with which the time of the supposed number of oscillations is known.

To furnish convenient numbers for calculating the time of ten oscillations, we observed usually at the end of fifty or one hundred oscillations, a number much below the limit allowed by the condition just referred to. An example will serve to show how fully this method, when properly applied, is to be relied upon.

Philadelphia, September 19th, 1835. Needle A.

Observed times of passage over the magnetic meridian.

	h.	m.	s.
P. M.	5	35	17.8
		31	18.0
		37	18.0
		43	18.0

The time of ten vibrations being known to be between 36 seconds and 36.4 seconds, there can be no doubt as to the number of vibrations corresponding to either of the intervals deduced from the observations just given. One hundred oscillations gives, from the interval between the first and second observations, 36.2 seconds, for the time of ten vibrations, while ninety-eight gives 36.75 seconds, and one hundred and two, gives 35.31 seconds for the same time. There is more certainty than could have been obtained by counting the whole number of vibrations, and quite as much as if each ten had been counted, and the time corresponding to it noted, as in the method usually practised.

The time of ten vibrations can obviously be found within the required limit of accuracy by one or two sets of ten vibrations, counted at the beginning of the experiment. When the limit of accuracy is fixed, it is easy to determine how many pairs of vibrations the needle may make before another observation for the time of passage is necessary.*

CORRECTIONS FOR TEMPERATURE.

In determining these corrections, we proceeded upon the principle usually assumed, that to equal increments of temperature correspond equal diminutions in the magnetic force of the suspended needle. This is, no doubt, approximately true within a moderate range of temperature. We also assumed, that the magnetic state of the needle is the same at the same temperature. The formula of professor Hansteen, based upon these suppositions, is,

$$T = T'\left(1 - m\,(t' - t)\right),$$

where T represents the time of making a certain number of oscilla-

* The following simple investigation will serve to determine the greatest admissible number of vibrations between two consecutive observations.

Let t = the time of 10 vibrations; n = the true number of vibrations in the whole time; e the greatest error in the observed time of 10 vibrations.

Then, $\frac{n\,e}{10}$ = the greatest error in estimating the whole time. That there may be no doubt as to the true value of n, we must have $\frac{n\,e}{10} < \frac{t}{10}$, or $n < \frac{t}{e}$.

To exemplify this, in regard to needle A, suppose $t = 36$ seconds, $e = .2$ second, we must have $n < \frac{36}{.2} < 180$.

lations at the temperature t, T′ the time of making the same number at the temperature t', and m is a constant to be determined by experiment, from the equation

$$m = \frac{T' - T}{T'(t' - t)}$$

The effect of the expansion of the needle upon its moment of inertia is, of course, too minute to enter into the discussion. The method adopted for finding this coefficient was similar to that described by Captain Sabine.* The observations in the first series were made in the small magnetic observatory, where most of the observations at Philadelphia were made.

In the First Series the arrangements for observing were as follows. The apparatus for oscillating was placed in a large wooden vessel, forming a considerable inclosure around it. The temperature of the inclosure, and of course of the apparatus, was lowered by filling around the latter with ice, the melting of which was occasionally promoted by sprinkling with salt. The top of the inclosure was covered, except only a sufficient space to look down upon the northern half of the needle, and upon the thermometer within the box. Access of air, and radiation from the sides of the observatory, were thus, in a great measure, cut off. A local dew point resulted from this arrangement, within the inclosure, which prevented embarrassment from the deposition of moisture upon the needle, or upon the glass cover of the box.

The needle to be observed having been allowed to remain in the box a sufficient length of time to acquire the temperature of the medium within, the experiment was commenced. The temperature of the box was noted, by the inclosed thermometer, at intervals during the oscillations, the temperature being made as nearly stationary as possible. The mean temperature thus obtained does not, of course, coincide with the half sum of the temperatures taken at the beginning and end, and which are recorded with the means in the table which follows.

The observation of the passage of the needle over the meridian, and of the arcs of vibration, had been rendered easy and accurate by tracing

* Brande's Quarterly Journal of Science, Vol. XXVIII. p. 14, &c.

on the glass cover of the box a zero line and graduations, similar to those on the scale at the bottom of the box.

Some of the results were carried from semi-arcs of twenty-five to three degrees, but the observations below the semi-arcs of five degrees are omitted. The series thus requires no correction for arc, to obtain relative results. The observations made below five degrees were not as accordant as those above; they were, however, few in number.

The experiments just detailed occupied almost the entire interval between $10\frac{1}{2}$ A. M. on the 25th, and $12\frac{1}{2}$ A. M. on the 26th of August 1834; they are, therefore, affected by the diurnal variation. Needle No. 1 was vibrated at intervals to determine the amount of this correction; but the nature of the results did not warrant the use of any correction derived from this source.

The following table contains the record of the observations just referred to. The several columns contain, first, the number of the experiment, for reference; second, the designation of the needle; third, fourth and fifth, the times of beginning and ending the oscillations; sixth, the temperatures at the beginning and end; seventh, the number of oscillations between the semi-arcs of twenty and of five degrees; eighth, the mean temperature; ninth, the time of ten vibrations.

TABLE No. I.

Observations for Correction for Temperature of Needles 1, 2 *and* 3.

No. of Experiment.	No. of Needle.	Times of Beginning and End.			Temperatures at Beginning and End.	No. of Vibrations.	Mean Temperature.	Time of Ten Vibrations.	Observers' Names, &c.
		Hours.	Mins.	Secs.	Fah.°		Fah.°	Secs.	
1.	1.	P.M. 12	38	44.0	36				August 25th, 1834.
		1	08	08.6	32	390	33.6	45.25	Bache.
2.	"	P.M. 4	30	19.2	$35\frac{1}{2}$				
			56	00.2	$35\frac{1}{2}$	340	35.7	45.32	Bache and Courtenay.
3.	"	P.M. 8	04	00.0	98				
			31	40.5	100	356	99.1	46.64	Bache and Courtenay.
4.	"	P.M. 11	51	16.4	98				
		A.M. 12	19	20.8	98	362	98 0	46.53	Bache. (August 26.)
5.	2.	P.M. 1	44	35.8	32				
		2	09	14.6	$32\frac{1}{4}$	340	32.2	43.50	Bache.
6.	"	P.M. 10	42	47.8	98				
		11	14	25.8	102	424	99.3	44.77	Bache and Courtenay.
7.	3.	P.M. 2	36	45.0	35				
			50	24.6	36	170	35.3	48.21	Bache.
8.	"	P.M. 9	51	22.2	102				
		10	06	16.2	$102\frac{1}{2}$	182	102.2	49.12	Bache and Courtenay.

The time was observed by a good pocket chronometer, making one hundred and fifty beats per minute, and the observed times of beginning and end are given to four-tenths, and probably with accuracy even to two-tenths of a second.

The irregularity in the number of vibrations between two given arcs was observed very generally in the first series of experiments, and is probably, in a great measure, due to the imperfect mode of estimating the arcs. It has little or no effect on the accuracy of the results, since even at the largest arcs many successive vibrations will be performed in times not differing appreciably from each other.

The coefficient for the correction for temperature of needle No. 1, as deduced from the experiments just given, is,

From experiments	1	and	3,	$m = .000,455$
	1	"	4,	$m = .000,427$
	2	"	3,	$m = .000,446$
	2	"	4,	$m = .000,417$
	Mean,			$m = .000,436$

Although it appears rather obvious that these several corrections do not differ essentially from the mean, it may not be amiss to show that the difference in the time of ten vibrations produced by using either of them, is within the probable limit of accuracy of the separate observations. By applying the first coefficient, which differs more from the mean than either the second or third, to deduce the time of ten vibrations at 98° Fah. from the observed time at 33.6, as given in the preceding table, we have 46.58 seconds: while the mean coefficient, similarly applied, gives 46.52 seconds, differing but .06 of a second in the time of ten vibrations. If now it be considered that these extremes of temperature are much further apart than in the cases occurring in the use of the needles, and further that the observations are to be reduced to a selected mean temperature, the result seems entirely satisfactory.

The coefficient for the reduction for temperature of needle No. 2, deduced from experiments five and six of the foregoing tables, is, $m' = .000,423$. That for No. 3, is $m'' = 000,277$.

No permanent change in the magnetic state of either of the needles was produced by the elevation of temperature to which they were subjected in these experiments.

In the SECOND SERIES of observations, the correction for temperature of Needle A, was obtained immediately after the observations at the different stations had been completed. As in the experiments already given, the temperature of the needle was lowered by ice, and raised by the heat from spirit lamps, placed in the same inclosure with the jar.

It was not convenient to observe the other needles at the same time, and the corrections applied to them were obtained in February, and within doors. Two questions were thus suggested: first, whether the correction for temperature is sensibly the same at different seasons, or whether a variation in the earth's magnetic intensity may produce a change in the distribution of the magnetism of a needle, so as to render it more or less liable to have its state changed by heat. Second, whether the local magnetism proportionably affects the magnetic state of a needle at different temperatures. As far as the practical use of the correction for our observations is concerned, both these questions were resolved. And from the answer, we felt warranted in deducing the corrections for the needles B and C, as above stated.

All the observations were made with the same thermometer which was used to give the temperature of experiment of the different stations. The observations for the correction for needle A, are contained in the following table, of which the form is similar to that before given. A column is introduced for the height of the gauge, and two others to contain the mean of the separate determinations at each temperature.

TABLE No. II.

Observations for the Correction for Temperature of Needle A.

No. of Observation.	Times of Beginning and Ending.			Temperature at Beginning and End.	Height of Gauge.	Number of Oscillations.	Mean Temperature.	Time of Ten Vibrations.	Mean Temperature of each set of Observations.	Mean Time of Ten Vibrations in each set.	Observers.
	Hours.	Mins.	Secs.	Fah.°	Inch.		Fah.°	Secs.	Fah.°	Seconds.	
	P.M. 4	14	26.4	72							October 5th,
	"	32	27.8	"	3	300*	72.0	36.05			1835.
		34	30.8	72							Bache and
1.		52	32.0	70½	4	300†	71.2	36.04	71.6	36.045	Courtenay.
	P.M. 6	31	57.2	36							
		46	55.2	32	4‡	250	33.7	35.92			
	6	59	07.6	32							Bache and
2.	7	17	04.0	36	3½	300	33.7	35.88	33.7	35.900	Courtenay.
	P.M. 8	42	23.2	61							
	9	00	23.6	62	3¾	300	61.7	36.01			
	9	02	55.2	62							Bache and
3.		20	56.2	64	4	300	62.9	36.03	62.3	36.020	Courtenay.
	P.M. 10	29	24.4	92							
		44	28.0	90	4¼	250	91.2	36.14			
	11	10	33.2	86							
4.		28	38.2	91	3	300	88.5	36.17	89.8	36.155	Bache.

The second set of observations was introduced to ascertain the allowance to be made for the diurnal variation of intensity. Reducing it to the temperature of the first set by using the mean coefficient from the entire series, it shows an increase in the time of ten oscillations between 4 and 5 P. M., the mean hour of making the first set, and 9 P. M., the mean hour of the third, of .022 seconds. Applying the proportional part of this correction to the sets numbered 2 and 4, the temperatures and times will be found to be as follows,

No. 1, 71.6°, 36.045 seconds.
2, 33.7°, 35.888 "
4, 89.8°, 36.124 "

And the corrections deduced from a comparison of the several sets will be more accordant, than when the daily variation is not considered. The values of the coefficient are,

* Terminated in an arc rather greater than two degrees.
† Terminated in an arc rather less than two degrees.
‡ Above four inches.

From Nos. 4 and 2, $m = .000,116$
" " 4 " 1, $m = .000,120$
" " 2 " 1, $m = .000,115$

Mean $m = .000,117$

It appears distinctly, from comparing these results, that the change of intensity of the needle's magnetism is greater at the higher temperatures than at the lower, for equal changes of temperature. The value of m, deduced from observations between 72° and 90°, is the greatest; next the value obtained between 34° and 90°, and last that between 34° and 72°. This change would have appeared greater if no correction had been made for the daily variation.

The second and third sets of observations on needle A, before referred to, are given in the annexed table. The object of these sets has already been explained.

TABLE No. III.

Observations for the Correction for Temperature of Needle A.

No. of Observation.	Times of Beginning and Ending.			Temperature of Beginning and Ending.	Height of Gauge.	No. of Vibrations.	Mean Temperature.	Time of Ten Vibrations.	Mean Temperature.	Mean Time of Ten Vibrations.	Place of Observation, &c.
	Hours.	Min.	Secs.	Fah.°	Inch.		Fah.°	Secs.	Fah.°	Secs.	
	P.M. 4	10	47.6	31							In small Observatory,
5.		22	45.2	29½	4	200	30.2	35.88	30.2	35.880	out of doors, Dec. 7, 1835. Bache.
	P.M. 5	31	36.0	86							
		43	40.0	90	+4*	200	88	36.20			
	5	46	48.8	92							
6.		58	53.2	92	+4	200	92	36.24	90.0	36.220	Bache.
	P.M. 7	49	22.4	31							
	8	01	20.8	32	+4	200	31.5	35.92			
	8	04	42.8	32							
7.		16	42.2	31	+4	200	31.7	35.97	31.6	35.945	Bache.
	P.M. 11	08	10.6	86							In the house, Feb. 1st,
		23	05.6	80	3½	250	84.0	35.80			1836.
	11	26	26.4	80							
8.		38	21.6	72	+4	200	76.0	35.76	80.0	35.780	Bache.
	A.M. 12	13	02.4	52½							Feb. 2d.
		24	54.4	50	+4	200	50.8	35.60			
	12	26	27.4	50							
9.		38	20.4	48	+4	200	49.2	35.65	50.0	35.625	Bache.

* This sign denotes that the gauge was above the mark to which the sign is prefixed.

A comparison of observations 5 and 7, after correcting the latter by an approximate coefficient for temperature, gives the amount of daily variation to be allowed for. Assuming the progress of this variation to be in proportion to the time, a correction is deduced for number 6, which is in the right direction, though small in amount. The coefficient deduced from 5 and 6 is $m = .000,147$. The coefficient before obtained was $m = .000,117$. It would certainly be rash to infer from the small difference thus rendered evident between the values of m, deduced under different circumstances, that the difference resulted from these circumstances. The times of vibration at corresponding temperatures, are greater in the second set of observations than in the first, as well as the differences for a given number of degrees. It is possible that the needle may have undergone a slight change between October and December, a question which future observations may determine. As far as the application to the observations which are to follow is concerned, these coefficients are so near to each other that either might be adopted without sensibly affecting the results. The difference would amount to but .01 second in ten vibrations, for ten degrees of temperature. From 8 and 9 uncorrected for diurnal variation, $m = .000,145$. The times of oscillation being nearly equally before and after midnight, about which time the march of the intensity begins to change its direction, a correction deduced from preceding observations, would probably render the results less accurate than they are without it.

The very close agreement of the two numbers just given for the coefficient, strengthens the opinion, that the difference from the number found in October results from a slight change in the magnetic state of the bar: the circumstances in the second and third sets of observations having been so very different as to local magnetism.

We infer from a comparison of the three values of m, that a coefficient for the correction for temperature, obtained under the circumstances of the second and third sets of observations, may safely be applied to correct, for temperature, the observations made during the summer and autumn.

The following table contains the observations made to obtain the correction to apply to needles C and B. The former has so small a correction that the observations upon it were quite laboured. It will probably be better not to go into the same detail in stating these results as in the former ones. With this impression we present the following table. The first column contains the number of the observation; the second, the designation of the needle; the third, the mean time at which the set of observations was made; the fourth, the number of oscillations from which the time of ten contained in the sixth has been calculated; the fifth, the mean temperature; the seventh, remarks, &c.

TABLE No. IV.

Observations for the Correction for Temperature of Needles C *and* B.

No. of Observation.	Designation of Needle.	Hours.	No. of Vibrations.	Mean Temperature. Fah.°	Mean Time of Ten Oscillations. Secs.	Remarks, &c.
						Bache, observer.
1	C.	2.1	550	47.8	32.005	February 1, 1836. In doors. Gauge $3\frac{1}{2}$ to $+4$.
2		4.5	1226	87.8	32.044	Jar leaks much, frequently exhausted. Sets of from
3		7.7	400	65.5	31.980	Gauge $3\frac{1}{2}$ to 4. [150 to 250 observations.
4		9.4	450	48.0	31.930	" 4 and above.
						Bache, observer.
5	B.	5.3	400	37.7	48.230	In doors. February 4th. Gauge about 4 inches.
6		7.7	320	89.9	49.085	Gauge $3\frac{1}{2}$ to 4.
7		9.6	284	45.2	48.260	" above 4. Jar leaks badly.

Needle B presents a curious case of correction for temperature. The diurnal variation shown from observations 1 and 3 is greater than the correction for eighteen degrees of temperature. This fact was perceived during the experiments, and led to the very frequent repetitions of the experiment at 87.8°, No. 2 of the table. Using observations 1 and 4 for the correction for change of intensity, and assuming that change to have been regular, observations 1 and 2 give for the coefficient of the correction for temperature,

$$m = .000,049,$$

And 1 and 3 give $\quad m = .000,056$

$$\text{Mean } m = .000,052$$

The progress of intensity within doors, as shown by observations 1 and 4, is contrary to that of the ordinary diurnal variation. This was correct, however, as was shown by six sets of observations between 3 h. 51′ and 5 h. 49′, at temperatures between 83.3 and 91.8°. The time of ten oscillations diminished from 32.115 to 32.035.

The same fact recurs in the observations on the 4th of February. From these, numbered 5, 6 and 7, allowing for the diurnal change of intensity deduced from 5 and 7, the value of m, for needle B, is, $m = .000,357$.

This supposes 7 to be reduced to the temperature of 5, by an approximate coefficient.

The correction obtained in 1834 for this same needle was $m = .000,277$.

It would seem to be rather more susceptible to changes of temperature now than at the former time. The difference however is small, amounting to about .04 of a second in ten vibrations, for ten degrees of the thermometer.

The coefficients used in correcting the observations which follow, are brought together in the following table.

TABLE V.

Correction for Temperature of Needles 1, 2, B, A *and* C.

First Series.	Value of m.	Second Series.	Value of m.
Needle No. 1	.000,436	Needle A	.000,117
" 2	.000,423	" C	.000,052
" 3	.000,277	" 3 (B)	.000,357

As far as we may be allowed to infer from these observations, the correction for temperature depends for its amount upon the degree of *hardness*, or temper, of the material of the needle; in other words, upon the same property which causes a needle to retain or to lose a charge once given to it.

Nos. 1 and 2, of different dimensions, but of the same material, have sensibly the same correction. C, which is certainly the hardest of the set, has a very small correction. The prismatic bar A has a correction intermediate between the two cylinders C and 3 (B), which are similar in their general proportions. The effects of figure and of relative dimensions seem to be without influence upon the result.

In all cases pains were taken to allow the needles time to arrive at the temperature of the inclosure, but observations made at intervals during the heating or cooling seem to show that this precaution was not essential.

These observations conclusively show the importance, and indeed the necessity, of determining a specific correction to be applied to each needle used in a series of observations for intensity. They confirm in this respect conclusions to which the observations of captain Sabine for obtaining the same correction, would seem to lead. The variation of these coefficients from each other, as well as from those of captain Sabine, and from that quoted as having been determined by professor Hansteen, agrees in the conclusion to which they lead. It is the more necessary to call special attention to this point, because the coefficient of professor Hansteen has been applied in the reduction of the observations (Royal Soc. Trans. 1828) for the relative intensities at Paris, London and Edinburgh, and more recently in a very extensive series of observations by M. Quetelet of Brussels, whose activity in this branch has of late years been particularly prominent.

A further inference may be deduced from these observations, viz. that a sensible change in the magnetic state of a bar, will be attended by a change in the correction to be applied for temperature. So that a correction once obtained should not be used after such a change has taken place in any considerable degree. In an extensive series of observations, it would therefore be necessary to investigate this correction during the time of making the observations, or before the series was commenced and after its completion.

In applying the correction for temperature, it is convenient, and generally admissible, to take for the multiplier of the coefficient just determined, a mean time of vibration, instead of the actual time in a given case.

That is, to take for the value of T,

$$T = T' - T'' . m (t' - t),$$

where T'' represents the mean time referred to. When the correction is not large, on account either of the value of m, or of $t' - t$, the differences will fall much below the errors in the observed times of oscillation.

CORRECTION FOR ARC.

In many observations in the FIRST SERIES, the horizontal oscillations were performed through arcs of very different extent. With needle No. 1, the semi-arc of vibration at the commencement of the experiment was, in some cases, 30°, and in others not more than 20°, the arc at the conclusion of the experiment depending, of course, upon its duration. Similar variations occur with the other needles. The most simple method, therefore, of rendering the results comparable is to reduce the times of oscillation to what they would have been in indefinitely small arcs. The formula for this purpose is the same with that investigated by Borda for the pendulum.* By applying the known values of the arcs observed at beginning and ending the experiment, the times are reduced in the tables which follow. Some error is, no doubt, introduced, particularly when these arcs are large, by the difficulty of observing accurately the extent of the arc of vibration, To diminish these, as far as possible, the arcs of vibration should be reduced to the smallest practicable limit, in order that the times in the different arcs may not vary too rapidly. The practice of oscillating in different arcs leading to a troublesome correction, is to be avoided. We find as the greatest semi-arc of observation suitable to be employed in such observations about fifteen degrees. The oscillation in a rarefied medium permits this to be much reduced.

In the SECOND SERIES all the observations were made within the same arcs, and are directly comparable. Needle A made 300 oscillations between the semi-arcs of 4° and 2° when the mercury gauge stood at three inches. At the same pressure C and B made 300 oscillations, between 6° and 2°. In such small arcs, the difference in the

*
$$T' = T\left(1 - \frac{\text{Sin.}\,(A + a)\,.\,\text{Sin.}\,(A - a)}{32\,M\,(\text{Log. Sin. }A - \text{Log. Sin. }a)}\right)$$
in which T′ is the reduced time of a given number of vibrations; T, the observed time; A and a the arcs at beginning and ending; M, the modulus of the common logarithms.

times of vibration resulting from differences of arc are entirely insensible.

We proceed now to give the observations and calculations for the magnetic intensity at the several places named in the title of our memoir.

RELATIVE HORIZONTAL INTENSITIES AT PHILADELPHIA AND WEST POINT.

Before giving the tables of observations at these two places, we propose to state the different occasions on which the observations were made.

First Series.

The first observations were made at West Point on the 21st of April 1834, with needle No. 1. This needle was then taken to Philadelphia, its rate ascertained (May 16th and 20th), and the needle returned to West Point, where it was observed, at intervals, during five weeks (from June 2d to July 8th). In this last period 3558 oscillations were observed. The same needle was oscillated at Philadelphia on the 5th of August, at West Point on the 13th, and again at Philadelphia on the 20th of the same month. These repeated transfers completely guard against the effect of change of rate in the needle.

No. 3 was first oscillated at West Point on the 23d of April, and again between the 28th of May and 9th of June. It was then transferred to Philadelphia, where it was observed on the 26th of June and 12th of July. It was taken to West Point and oscillated on the 7th and 8th of August, and finally observed at Philadelphia on the 20th and 25th of August.

This series comprises 6478 oscillations at West Point, and 7069 at Philadelphia.

The observations at Philadelphia were made at two different places in the city. In part of the series the apparatus was placed in the open air upon a marble column, and in the other part, in a small observatory; both in the yard attached to professor Bache's dwelling.

The observations at West Point were made upon a small brick column, north of professor Courtenay's house.

It is certain, that considerable differences in local attraction exist at different positions of this highland station. The place of observation is at the base of the hills which inclose, on the west, the table land upon which the buildings of the Military Academy are situated.

The series embracing observations at different hours of the day, with different states of weather, &c., are the more valuable, as presenting a nearer approximation to the mean intensity. In all the remarks and calculations which follow, the intensity is assumed to be constant.

The times, at West Point, were observed by a chronometer by Parkins and Frodsham, of excellent character: those at Philadelphia by a pocket chronometer by Barraud, and by one by French, both of good character. The daily rates were too small to produce any sensible difference by correcting the observations for them.

In the following table, No. VI., the first column contains the number of the observation; the second, the designation of the needle; the third, the date of observation; the fourth, the time of beginning; the fifth, the duration of the experiment; the sixth, the number of vibrations; the seventh, the mean temperature; the eighth, the arcs at beginning and ending; the ninth, the duration of experiment corrected for arc; the tenth, the duration corrected for arc and temperature; the eleventh, the time of ten vibrations corrected for arc and temperature; the twelfth, the state of the weather; and the thirteenth, the names of the observers.

The table of observations at West Point, No. VII., is arranged in a very similar manner to that just described.

The temperature to which the results are reduced is 60° Fah.

TABLE No. VI.

Observations at Philadelphia.—FIRST SERIES.

No. of Experiment.	Designation of Needle.	Date of Experiment.	Time of Beginning Experiment.			Duration of Experiment.	No. of Oscillations.	Mean Temperature.	Arc at Beginning and Ending.	Duration of Experiment corrected for Arc.	Duration of Experiment corrected for Arc and Temp'ture.	Corrected Time of Ten Oscillations.	State of the Weather.	Observers' Names.
			Hours.	Mins.	Sec.	Secs.		Fah.°	Degs.	Secs.	Secs.	Secs.		
1	No. 1.	May 16	P.M. 6	13	13.8	2209 8	480	60.0	35 to 5	2198.1	2198.1	45.79	Clear. Cumulus.	H. D. Rogers and Bache.
2	“	“ 20	“ 5	29	42.2	2049.8	440	85.7	“	2038.9	2015.7	45.81	Hazy.	Bache.
3	“	Aug. 5	A.M. 7	21	09.6	3035.6	654	83.5	20 to 3	3029.9	2998.4	45.84	Clear.	“
4	“	“ “	“ 8	33	04.8	1035.6	232	87.5	20 “ 10	1081.3	1068.1	46.04	“	“
5	“	“ “	P.M. 7	04	56.0	2372.0	510	87.2	20 “ 3	2367.5	2339.2	45.87	“	“
6	“	“ 20	“ 3	58	10.8	2082.4	452	92.9	19 “ 3	2078.8	2048.7	45.33	Clear. Cumulus.	“ “
7	“	“ “	“ 8	14	12.0	2486.8	538	93.5	20 “ 3½	2481.7	2444.9	45.45	“	“
8	“	“ “	“ 10	24	33.6	2212.4	486	55.5	20 “ 3	2208.2	2212.6	45.53	“	“
9	“	“ 25	“ 8	10	05.2	1660.4	356	99.1	20 “ 5	1656.1	1627.4	45.71	Cloudy.	“
10	“	“ “	“ 11	51	16.4	1684.4	362	98.0	20 “ 5	1680.0	1651.7	45.63	“	“
14	No. 3.	June 26	P.M. 7	10	00 0	1086.8	220	82.5	30 “ 5	1082.1	1071.3	48.68		Bache.
15	“	July 12	“ 4	31	28.0	1411.8	290	84.5	15 “ 2	1410.4	1395.1	48.11	Cloudy.	“
16	“	“ “	“ 5	14	00 0	1460.8	300	83.5	15 “ 3	1459.0	1443.8	48.13		“
17	“	Aug. 20	“ 6	04	39.6	1290.8	264	84.4	20 “ 3	1288.4	1274.5	48.28	Clear.	“
18	“	“ 25	“ 9	51	22.2	894.0	182	102.2	20 “ 5	891.7	875.0	48.08	Cloudy.	Bache and Courtenay.

Needle No. 1. Whole No. of Vibrations 4510; Whole time, 20,604.8 Secs.; Mean Time of Ten Vibrations, 45.687 Secs.
3. “ 1256; “ 6,059.7 “ “ 48.246 “

TABLE No. VII.

Observations at West Point.—FIRST SERIES.

No. of Experiment.	Designation of Needle.	Date of Observation.	Duration of Experiment.	No. of Oscillations.	Temperature of Needle.	Arc at Beginning and Ending.	Duration of Experiment corrected for Arc.	Duration of Experiment corrected for Arc and Temp'ture.	Corrected Time of Ten Vibrations.	Observers' Names.
			Secs.		Fah.°	Degs.	Secs.	Secs.	Secs.	
1	No. 1.	April 21	953.8	200	63	25 a 15	945.6	944.3	47.22	Courtenay and Bache.
2	“	“ 22	752.5	160	49	25 a 10½	758.4	752.1	47.01	“
3	“	June 2	960.5	200	74	30 a 15	952.2	946.5	47.32	Courtenay and Cram.
4	“	“ “	1142.4	238	“	“	1132.6	1125.8	47.30	“
5	“	“ 9	971.7	200	89.2	“	963.3	950.8	47.54	“
6	“	“ “	1018.7	210	“	“	1010.0	996.9	47.47	“
7	“	“ 14	1958.5	410	66½	30 a 5	1950.0	1944.6	47.43	“
8	“	July 1	1913.7	400	74	30 a 4	1906.3	1894.9	47.37	Courtenay.
9	“	“ “	1916.5	“	79	30 a 5	1908.2	1892.1	47.30	“
10	“	“ 3	1919.2	“	74½	“	1910.9	1899.0	47.47	“
11	“	“ 7	1926.8	“	82	30 a 6½	1917.2	1898.5	47.46	“
12	“	“ 8	1924.0	“	81	“	1914.4	1896.4	47.41	“
13	“	“ 12	955.5	200	71	20 a 10½	951.5	946.9	47.34	“
14	“	“ “	955.7	“	78	20 a 7	952.8	945.3	47.26	“
15	“	“ “	956.0	“	72½	20 a 7½	953.1	947.9	47.39	“
16	“	Aug. 12	1675.5	348	86	20 a 3	1672.3	1653.0	47.50	Courtenay and Bache.
25	No. 3.	April 22	515.5	100	52	30 a 14	501.4	502.5	50.25	“
26	“	May 28	515.2	“	64	40 a 19	508.0	507.4	50.74	Courtenay and Cram.
27	“	“ 30	516.1	“	“	40 a 22	508.1	507.5	50.75	“
28	“	June 2	517.0	“	71½	40 a 17	510.4	508.8	50.88	“
29	“	“ 9	520.7	“	89¼	39 a 21	513.1	508.9	50.89	“
30	“	Aug. 7	1537.8	300	82	30 a 4	1531.9	1522.5	50.75	Courtenay.
31	“	“ 8	1543.9	“	84	“	1537.9	1527.5	50.92	“

Needle No. 1. Whole No. of Vibs. 4566; whole time, 21,635.0 secs.; Mean time of 10 Vibs. at 60° 47.381.
3. “ 1100; “ 5,585.1 “ 50.774.

The horizontal intensities deduced from a comparison of these last results with those obtained at Philadelphia, are, from No. 1, .92977; and from No. 3, .90290, the horizontal intensity at Philadelphia being assumed as unity. The relative weights of the observations with the two needles, taking the whole number made with each needle as belonging to one set of observations, will be, according to the formula of Gauss,*

$$\text{For No. 1, } 2 \times \frac{4566 \times 4510}{9076} = 4540;$$

$$\text{And for No. 3, } 2 \times \frac{1100 \times 1256}{2356} = 1174.$$

The mean horizontal intensity thus deduced is, .92424. An arithmetical mean of the two intensities would have given .91633, a number differing sufficiently from that just found, to make the calculation worth pursuing, notwithstanding that it is less than the difference of the intensities determined by the two different needles.

SECOND SERIES.

These observations were made on the 7th and 8th of September 1835, at West Point, and in September and October in Philadelphia. They were made in the vacuum apparatus, and although the number of observations is not equal to that of the first series, the mean error is so much diminished by the superior accuracy of the results in the rarefied medium, that the weight of the observations is very much greater than that of the more numerous ones of the first series.

The following tables, Nos. VIII. and IX., are arranged nearly as the preceding ones, and require no specific description.

The table for Philadelphia contains observations with needle No. 3 (B), for comparison with others with the same needle at different places. This needle was not oscillated at West Point.

* Baily in Trans. Astr. Soc. Lond., Vol. II. p. 19.

TABLE No. VIII.

Observations at Philadelphia.—SECOND SERIES.

No. of Experiment.	Designation of Needle.	Date of Observation.		Time of Beginning.	Duration of Experiment.		Mean Temperature.	No. of Oscillations.	Time of Ten Oscillations.	Time of Ten Oscillations corrected for Temperature.	Weather and Remarks.	Observer, &c.
				Hours.	Mins.	Sec.	Fah.°		Secs.	Secs.		
		1835.										
1	A	Sept.	19	P. M. 5.4	18	00.2	68.2	300	36.01	36.02	Cloudy. E. Nimbus.	Bache.
2	"	"	30	" 3.5	18	00.6	63.9	300	36.02	36.05	Cloudy. Wind N. W.	Place of
3	"	"	"	" 3.8	15	00.4	63.1	250	36.02	36.05	Cumulus.	Observation,
4	"	Oct.	5	" 4.2	18	01.4	72.0	300	36.05	36.04	Cloudy. N. E. wind.	Small
5	"	"	"	" 4.6	18	01.2	71.2	300	36.04	36.04	Cumulo-stratus.	Magnetic
6	"	"	"	" 6.5	14	58.0	33.7	250	35.92	36.07	In ice.	Observatory
7	"	"	"	" 7.0	17	56.4	33.7	300	35.88	36.03	"	in rear of
8	"	"	"	" 8.7	18	00.4	61.7	300	36.01	36.05	"	Prof. Bache's
9	"	"	"	" 9.0	18	01.0	62.9	300	36.03	36.06	"	dwelling,
10	"	"	"	" 10.5	15	03.6	91.2	250	36.14	36.05	Heated by lamps.	Chesnut St.
11	"	"	"	" 11.2	18	05.0	88.5	300	36.17	36.09	"	near Schu'kll
12	"	"	17	" 3.9	12	02.4	77.2	200	36.12	36.09	Cloudy. S. E.	Sixth.
13	C	Sept.	18	P. M. 5.3	16	05.2	69.4	300	32.17	32.17	Clear. S. E. Cirro-	Bache.
14	"	"	"	" 5.6	16	05.6	68.1	300	32.19	32.19	Cumulus—rare.	Place
15	"	"	19	" 3.9	16	06.4	69.5	300	32.21	32 21	Cloudy. Nimbus.	of
16	"	"	"	" 4.4	16	05.4	69.0	300	32.18	32.18	Wind E.	Observation
17	"	"	"	" 5.0	13	24.4	68.0	250	32.18	32.18	"	as above.
18	B	Oct.	5	P. M. 3.3	20	26.0	74.0	250	49.04	48.97	Cloudy. N. E.	Bache.
19	"	"	"	" 3.6	20	27.2	73.4	250	49.09	49.03	"	Same Place of Observation.

Mean Time of Ten Oscillations at 70° Fah. by A, 36.053 in Semi-arcs of 4 a 2°. Total No. of Vibs. 3350.
" C, 32.186 " 6 a 2°. " 1450.
" B (3) 49.000 " " " " 500.

TABLE No. IX.

Observations at West Point.—SECOND SERIES.

No. of Experiment.	Designation of Needle.	Date of Observation.	Time of Beginning.	Duration of Experiment.		Mean Temperature.	No. of Oscillations.	Time of Ten Oscillations.	Time of Ten Oscillations corrected for Temperature.	Weather, &c.	Observer, &c.
			Hours.	Mins.	Secs.	Fah.°		Secs.	Secs.		
1	A	Sept. 7	P. M. 5.0	18	48.4	69.9	300	37.61	37.61	Clear. Wind N.	Bache and
2	"	" "	" 5.3	18	47.6	66.8	"	37.59	37.60	of W.	Courtenay.
3	"	" 8	A. M. 10.1	18	44.7	64.0	"	37.49	37.52	Clear. W.	Same locality as
											in former Ob-
4	C	Sept. 8	A. M. 10.9	16	44.6	70.3	302	33.27	33.27	Clear. W.	servations.
5	"	" "	" 11.2	16	37.6	69.5	300	33.25	33.25		
6	"	" "	" 11.6	16	44.6	71.9	302	33.27	33.27		

Mean Time of Ten Oscillations at 70° Fah. by A, 37.577 in Semi-arcs fr. 4 to 2°. No. of Oscillations 900.
" " " C, 33.263 " 6 to 2°. " 904.

The horizontal intensity compared with that at Philadelphia is, from A, .92053, and from C, .93630. The relative weights to be attached to the results with the two needles are, respectively, 1419 and 1113.

We now proceed to compare the horizontal intensities, deduced from both series of observations, to obtain the mean.

As the methods of observation in the two series are liable to different errors, and the number of observations are different, we have allowed to the results obtained by them, weight in proportion to the number of observations directly, and the square of the mean error inversely. The mean error is hardly attained, even in the case of the greatest number of sets of observations of the second series; but an approximation to it will afford a far more satisfactory mode of deducing the mean intensity than could be obtained by an indiscriminate mean of the results.

The numbers found for the weight of the observations with each needle in the two series, have been of course used instead of the number of observations, as referred to in the preceding paragraph. And a mean error has in like manner been deduced from the combined observations with each needle at the two places. Using these numbers, we have obtained the following for the relative weights of the observations with each needle.

First Series.	No. 1,	2728	Second Series.	A,	29319
"	3,	476	"	C,	1136.

By the use of these numbers, and of the horizontal intensities already obtained, we have for the mean, $h' = .92156$.

The superiority of the method in the rarefied medium, cannot better be shown than by stating, that the mean error with needle A, supposing it reached in the observations, was .022 seconds in about $36\frac{1}{2}$ seconds, while, with No. 1 in the first series, it was .129 seconds in about 46 seconds, or six times the former.

The probable error* in the time of ten vibrations of Needle A is, .0005 second.

* Deduced from the formula $P = 85\frac{e}{\sqrt{n}}$. Young, Phil. Trans. 1819, p. 77.

RELATIVE INTENSITIES AT NEW YORK AND PHILADELPHIA.

The observations to be presented belong to both series. Those of the first are retained as second in number to the Philadelphia and West Point observations of the same series. The observations of the first series were made in April and in August 1834. In the first set I had the kind assistance of professor Renwick; the times were observed with a pocket chronometer belonging to him, the rate of which was ascertained, but was not such as to affect the results sensibly. At his suggestion the observations made at Columbia College green were checked by a set made near Bellevue. Another set was made in the north part of the city, but there appeared no difference of local attraction in the three places. The pocket chronometer used in the August observations was of good character.

TABLE No. X.

Observations at New York.—FIRST SERIES.

Designation of Needle.	Date of Observation.	Time of Beginning.	Temperature of Needle.	Number of Oscillations.	Arc at Beginning and End.	Observed Time of Ten Vibrations.	Time of Ten Vibrations corrected for Arc and Temperature.	Weather, &c.	Observers and Places of Observation.
		Hours.	Fah.°		Degs.	Secs.	Secs.		
	1834.								
No. 1.	April 25	A. M. 8.0	42	330	25 a 5	46.03	46.24	Wind N. W.	Prof. Bache & Renwick.
"	" "	" 8.5	"	320	"	46.05	46.26	Nimb. & Snow.	Col. College Green.
"	" "	P.M. 12.6	44.5	350	"	46.20	46.36	Slight Rain.	Bache. Rose hill.
"	" 24	" 6.1	50	280	"	46.24	46.28	W'd high N.W.	Bache. No. 31, 5th St.
"	August 7	A. M. 6.2	76	548	20 a 3	46.98	46.56	Clear. N. W.	Bache. Colum. College Green.
Needle No. 1; No. of Vibrations 1828; Time of 10 Vibrations at 60°, reduced for Arc, 46.340 Secs.									

Comparing this result with the mean time of No. 1 at Philadelphia, we have the relative horizontal intensity at New York, .97202. The time of ten oscillations as observed in August, indicates a real diminution of intensity in the magnetism of the needle or of the earth. The observations at Philadelphia do not indicate a change in the magnetism of the needle, we have therefore retained this result, and used it in obtaining the mean.

SECOND SERIES.

The observations of the second series were made in August and September 1835, with needles A and C. The following table contains the results.

TABLE No. XI.

Observations at New York.—SECOND SERIES.

No. of Experiment.	Designation of Needle.	Date of Observation.	Time of Beginning.	Duration of Observation.		Temperature of Needle.	No. of Oscillations.	Time of Ten Vibrations.	Time of Ten Vibrations corrected for Temperature.	Weather, &c.	Observer, &c.
			Hours.	Min.	Sec.	Fah.°		Secs.	Secs.		
1	A	August 5	P. M. 5.1	18	35.6	71.0	302	36.94	36.94	Cldy. S.W.	Bache. Place of Observ.
2	"	" "	" 5.6	19	12.8	71.0	310	36.95	36.95	Cumulus.	Yard in rear of dwell-
3	"	" 6	A. M. 10.8	20	19.0	68.9	330	36.94	36.94	Cloudy. E.	ing of E. Martin, Esq.
4	"	" "	" 11.3	17	07.0	69.7	278	36.94	36.94	Nimbus.	No. 31, 5th Street.
5	"	Sept. 10	P. M. 5.1	17	33.0	76 2	284	37.07	37.04	Cldy. S.W.	Bache.
6	"	" "	" 5.4	15	56.9	75.2	258	37.09	37.06	Cumulus.	
7	"	" "	" 5.7	18	39.2	73.5	202	37.06	37.04	"	
8	C	Sept. 10	P. M. 7.5	16	19.4	73.5	296	33.08	33.08	Cldy. S.W.	Bache.
9	"	" "	" 7.8	16	32.2	71.0	300	33.07	33.07	Cumulus.	

Mean Time of Ten Oscils. at 70° Fah. in Aug. by A, 36.941 in Semi-arcs of 4° a 2°. No. of Vibs. 1220.
" " " Sept. " " 37.047 " " " " 744.
" " " " " C, 33.075 " 6° a 2°. " 596.

The times of vibration observed in the beginning of the month of August are all less than those observed in September, probably from a slight change in the magnetism of needle A, with which the observations were made. This change, however small, renders it expedient to compare only the September observations with those at Philadelphia. From the mean of these, we have,

Relative horizontal intensity at New York, by A, 0.94707,
" " " " C, 0.94697.

These results agree very well together, but not very well with that from the first series, Table X. As from the comparisons at West Point and Philadelphia, there does not appear to have been a real change in the intensity of the earth's magnetism between the times at which the two series of observations were made, it will probably be more accurate to take the mean of the two determinations. Allowing weight to the different sets according to the method before explained, we have for the mean horizontal intensity,

$$h'' = .94705.$$

By comparing this result with the mean of the observations made in full air, it will be seen, that in determining the value of h'' the first series of observations has hardly any weight, and we propose in the cases which follow, where observations were made by both methods, to omit those of the first series entirely. In no one of the cases alluded to were the observations of the first series as numerous as at New York. And the comparison has probably been carried sufficiently far to show the superior value of the results in rarefied air; the comparisons having been made according to principles involving the mean error to which the methods are liable, as deduced from the observations themselves.

MAGNETIC INTENSITY AT NEWPORT, R. I.

The observations at Newport were made during a visit there in the months of August and September 1835. They all belong to the SECOND SERIES, and were made in nearly the same place, and, with few exceptions, about the same period of the day. The results with all three of the needles agree very nearly; the greatest number of observations having been made with needle A, and the least with No. 3 (B).

We have abridged this table by omitting the column for the duration of the observations.

TABLE No. XII.

Observations at Newport, R. I.—SECOND SERIES.

No. of Experiment.	Designation of Needle.	Date of Observation.	Hour of Beginning.	Temperature. Fah.°	No. of Vibrations.	Observed Time of Ten Vibrations. Secs.	Corrected Time of Ten Vibrations. Secs.	Weather, Wind, &c.	Observers, &c. Place of Observation.
		1835.							
1	A	Aug. 19	A.M. 10.1	86.2	350	38.14	38.07	Clear. S. W. Cirrus.	Bache and Courtenay.
2	"	" "	" 10.5	87.2	348	38.09	38.01		
3	"	" 20	" 10.4	76.5	350	38.00	37.97	Clear. Cloudless. S. E.	
4	"	" "	" 10.8	77.5	352	37.99	37.95	At 8 A. M. North.	In the Garden in rear of
5	"	" 21	" 10.7	74.7	350	38.03	38.01	Cloudless. W. S. W.	Wm. Littlefield, Esq.,
6	"	" "	" 11.3	76.0	300	38.00	37.97		corner of High and
7	"	" 25	" 10.1	75.2	300	38.06	38.03	Clear. S. W.	Mary streets.
8	"	" 31	" 10.7	75.2	300	38.06	38.03	Overcast. S W.	
9	"	" "	" 11.1	75.6	306	38.03	38.00		
10	C	Aug. 25	A.M. 11.1	78.2	300	33.88	33.87	Clear. S. W.	Bache and Courtenay.
11	"	" 26	" 10.1	78.7	300	33.97	33.96	S. W. Clear.	
12	"	" "	" 10.4	80.0	284	33.98	33.96		
13	"	" 27	" 9.7	73.6	300	33.93	33.93	Clear. N. W.	
14	"	" "	" 10.0	74.5	236	33.95	33.94		
15	"	" 31	" 12.4	78.7	300	33.93	33.92	Overcast. S. W.	
16	"	" "	" 12.7	78.5	300	33.92	33.91		
17	No 3	Aug. 25	A.M. 10.9	77.5	164	51.57	51.44	Light haze. S. W.	Bache and Courtenay.
18	"	" "	" 11.2	77.9	250	51.57	51.43		
19	"	" 27	P.M. 5.6	71.5	250	51.51	51.48	Clear. N. W.	
20	"	" 31	A.M. 12.0	78.5	150	51.67	51.51	Overcast. S. W.	

Mean Time of Ten Vibs. at 70° Fah. by A, 38.004 in Semi-arcs of 4° to 2°. Total No. of Vibs. 2956.
" " " C, 33.927 " 6° to 2°. " " 2020.
" " " (B) 3, 51.465 " " " " 814.

From these observations are deduced the following relative horizontal intensities, the same element as Philadelphia being taken as unity.

From Needle A, 0.89996
" " C, 0.90000
" " 3, 0.90651

The mean of these, taken according to principles heretofore stated, gives for the relative horizontal intensity, $h''' = 0.90086$.

INTENSITIES AT PROVIDENCE, R. I., SPRINGFIELD, MASS., AND ALBANY, N. Y.

For the horizontal intensities at these several places, we rely entirely upon the SECOND SERIES of observations.

The observations at Providence were made on a visit there for the purpose; and the kind assistance of professor Caswell, of Brown University, rendered them easy, notwithstanding the unfavourable condition of the weather. The place of observation was north of the College buildings. It will be seen that the results here obtained accord very well with the deductions from numerous observations at Newport, which is about thirty miles south of Providence.

In crossing from Providence to Albany, N. Y., one of us observed at Springfield, Mass., seventy-five miles west from the former place. The place of observation was highly favourable, being in an open field, remote from buildings, and well shaded from the sun.

At Albany the place of observation was less favourable, being inclosed by buildings.

The results are given in the following table.

TABLE No. XIII.

Observations at Providence, Springfield and Albany.

No. of Experiment.	Designation of Needle.	Date of Observations, and Place.	Time of Beginning.	Temperature.	No. of Oscillations.	Time of Ten Oscillatoins.	Corrected Time of Ten Oscillations.	Weather, Wind, &c.	Locality of Observations and Observers.
			Hours.	Fah.°		Secs.	Secs.		
		Providence, R. I., 1835.							
1	A	Aug. 28	P. M. 1.5	71.0	298	38.08	38.08	Nimbus. S. E. wind.	Bache. Place of Ob-
2	"	" "	" 1.8	70.5	300	38.08	38.08	Showers during Ob-	servation to North
3	C	" "	" 12.6	73.0	300	33.99	33.99	servations.	of N. College Hall,
4	"	" "	" 12.9	71.5	308	33.95	33.95	Rains.	Brown University.
5	No.3	" "	A.M. 11.4	76	264	51.61	51.50		
6	"	" "	" 11.8	75 7	252	51.63	51.52	Rains.	
		Springfield, Mass. 1835.							
7	A	Sept. 4	P. M. 1.7	77.0	298	38.35	38.32	Slightly hazy. Wind	Bache. Place of Ob-
8	"	" "	" 2.0	77.5	302	38.30	38 26	S. by W.	servation on N. E.
9	"	" "	" 2.4	77.8	250	38.30	38.26		side of a large Elm
10	C	" "	" 3.9	78 9	300	34.20	34.18		tree in rear of Pin-
11	"	" "	" 4.3	78.9	300	34.20	34.18		chyn house.
12	No.3	" "	" 4.8	79.4	270	52.12	51.95		
13	"	" "	" 5.2	76.0	250	52.16	52.05		
		Albany, N. Y. 1835.							
14	A	Sept. 6	A. M. 9.7	85.1	256	39.13	39.06	Cloudy. Wind S.	Bache. Place of Ob-
15	"	" "	" 10.2	87 8	300	39.12	39.04	Clouds from S. W.	servation, yard in
16	"	" "	" 10.6	91.5	300	39.16	39.06	Aurora last night.	the rear of Franklin
17	C	" "	" 11.5	88.8	300	34.87	34.82		House, State street.
18	"	" "	" 12.1	90.5	300	34.89	34 84		

Providence.	Mean Time of 10 Oscils.,	&c. by	A, 38.080	in Arcs of	4° to 2°.	Total No. of Vibs.	598.
	"	"	C, 33.970	"	6° to 2°.	" "	608.
	"	"	No. 3, 51.510	"	"	" "	516.
Springfield.	"	"	A, 38.280	"	4° to 2°.	" "	850.
	"	"	C, 34.180	"	6° to 2°.	" "	600.
	"	"	No. 3, 52.000	"	"	" "	520.
Albany.	"	"	A, 39.053	"	4° to 2°.	" "	856.
	"	"	C, 34.830	"	6° to 2°.	" "	600.

From these are deduced the horizontal intensities given below: the relative weights of the observations, considering them to be liable to the same mean error, and the mean horizontal intensities deduced from a comparison of the different results according to their weights, are as follows.

Places.	Relative Horizontal Intensities by Needle.			Weights of Observation by Needle.			Mean Horizontal Intensities.
	A	C	No. 3	A	C	No. 3	
Providence, R. I.	.89637	.89773	.90492	508	428	254	.89869
Springfield, Mass.	.88703	.88673	.88794	678	424	255	.88711
Albany, N. Y.	.85226	.85394		682	424		.85290

ON THE TOTAL MAGNETIC INTENSITY.

We have already remarked, that we do not consider the dip to be sufficiently well known at any of the places at which we have deduced the horizontal intensities, to admit of combining the results for the total intensity. For example, at Albany the difference of eleven minutes between our observations and those of professor Henry, corresponds to a difference in intensity of 0.01177. The places at which the observations were made lie so nearly upon the line of equal intensity as to render so rude an approximation entirely inadmissible. The general direction thus pointed out for this line, accords with the general direction formerly assigned by captain Sabine.*

* American Jour. Science, Vol. XXII. Letter to Professor Renwick.

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—— Nouv. Dict. Polonois, Allemand et François. Par M. A. Trotz. Leipzig, 1764.

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—— Inquiry into the Rise, Progress, and Present State of the National Debt of Great Britain, by R. Hamilton. Philad. ed., 1816.
—— Mem. of the Protect. House of Cromwell, and its Connections, by M. Noble. 2 Vols, 8vo. Birmingh., 1784.
Vaux (Geo.) Calculat. of a remarkable Eclipse of the Sun, 24th June 1778, for the Merid. Philad., by Don Freehauff. MS.
Walker (C. S.) A Hist. of the Brit. Animals, arranged according to their Gen. and Spec. 8vo. Edinb., 1728.
Wallich (N.—M.D.) Descript. of some rare and curious Plants, Calcutta, 1834. 8vo.
—— Discovery of the genuine Tea Plant in Upper Assam, with a plate. 1835.
Walsh (Rob.) A large collection of Pamph. on various subjects, and interesting Docum.
—— Kent's Comment. on Amer. Law. Vols 2, 3, 4. 8vo. New York, 1827—30.
—— Gray's Elements of Botany. 12mo. N. York, 1836.
Warden (D. B.) L'Art de vérifier les Dates depuis 1770, suite de la Chronol. d'Amérique. Vol. 15, sur la Guiane Française, &c., dirigé par Le Marq. de Fortia. Paris, 1834.
—— Etudes sur l'Archæolog., sur un Monum. Biblique trouvé à Thêbes, et sur les Méthodes de Young et de Champollion, J.; Essai sur quelq. Zodiaques des Indes, par M. de Paravey. 1833.
—— Hazard sur l'Education des Vers à Soye, dans le Nord et Centre de la France.
—— Notices sur les Puits artésiens d'Essone, Corbeil, &c., Départ. de Seine et Oise, par Vt. Héricart de Thury. Paris, 1835.
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—— A Collection of Catalog. of Modern Lit. and Science; also a number of Pamphlets on various branches of Sci. and Lit. Proceedings of learned Societies, &c.
Wetherill (J. P.) H. Binney's Eulogy on the Life and Charact. of John Marshall, Chief Justice of the United States, delivered at the request of the Councils of the City of Philad., 1835.
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Elémens de La Langue Turque, par Viguier. Constantinople, 1790. 4to.
The Bible, in the Turkish Language. Paris, 1827. Fol.
Anglo-Arabic Primer and Vocabulary. Malta, 1832. 12mo.
The Anglo-Greek Primer, by S. S. Wilson. Malta, 1819. 18mo.
Turjeman Nameh, The Dragoman's Book. (Turkish.) 4to., MS.
Emtsali Soleiman, Solomon's Proverbs, in Persian. 12mo. London, 1831.
Irashai Merghoub, The Delectable Letters. (A Turkish Letter Writer.) MS., 4to.
An Arabic and Turkish Dictionary. Constantinople, A. H., 1242. Fol.
An Arabic Grammar for the use of the Turks, printed by order of the Sultan Mahmoud II. 4to. Const. (No date.)
Feriad ul Fuwaid, &c., Pearls of advantage in the Exposition of Doctrine. Constant., A. H., 1232. 4to.
The Imperial Firman of Sultan Abd-ul-Hamid, dated at Constantinople, A. H., 1193, appointing Seid Othman, one of the Ulemas, to succeed his deceased father to the Imamate of the mosque Selatin Oghlou, at Smyrna (original).
A file of Turkish Newspapers.

DONATIONS FOR THE CABINET

A Marble Bust of Peter S. Du Ponceau, President of the Society. By Fiorelli. Presented by Members of the Society.

The Administrators and Professors of the Museum of Natural History, Paris, transmitted to Richard Harlan, M.D., to be presented to the American Philosophical Society, a highly interesting Collection of Models, in plaster, of Fossil Bones, sixty-eight in number, comprising:

Two Heads, Lower Jaw, and left hind Foot, of the Palæotherium Crassum.
Also Models of Parts of the Pal. Magnum, Pal. Medium, and Pal. Indeterminatum.
Also of Parts of the Anoplotherium Commune, and of the Lophoidon or Tapiroide.
Also of Two Heads and one perfect Skeleton of the Icthyosaurus.
Also of the Head and many other Parts of the Saurien; Also head of a Tortoise.
Also of forty plaster Models of Parts of the Crocodile of Caen.
Also of a portion of the Lower Jaw, &c. of the Anthracotherium, and an entire Jaw.
Also of several Parts of the Rhinoceros (from Chevilly).
Also a Lower Grinder of the Tapir.
Also a Lower Grinder of the Gigantic Tapir.
Also of a Head of a Bear, found in a Cavern of Westphalia.

Burrough (M.) A portion of the Seed of the Prangass Plant, from the Territory of Muharajah Ranjeet Sing, a grass of singular fertility and value, which grows in the

Burrough (M.)—*continued.*
mountains of Thibet, and which, from the jealousy of the natives, was procured with difficulty.

—— Also a Collection of Copper Coins, chiefly from Thibet.

Bache (H.) His Survey of Charleston Harbour, S. C., and the contiguous Coast and Country. By H. Bache, Captain of Top. Engin. of U. S., and his Assistants. 1823—4—5.

Bonaparte (Joseph Count Survilliers) An Antique Etruscan Cup, found on the estate of Lucien Bonaparte, Prince of Canino, in the researches made in 1828—9, in that district, where the ancient Capitol of the kingdom of Etruria, called Vitulonia, once stood. Accompanied by the "Museum Etrusque of Lucien Bonaparte," containing a description of nearly two thousand articles, found in the same locality, and the 1st and 2nd parts of the plates, in fol.

Carrera (Mad.) Specimen of the Lace Tree of Cuba, being a Branch, showing it in its natural state and also when developed, called Daguila (Lagetta Lintearia).

Fletcher (Thos.) A proof engraved Print of John Dalton.

Fisher (I. F.) Four Roman Coins, of which three are silver; and five American Copper Coins, struck during the confederation.

—— A Collection of Coins, forty seven silver, and one hundred and four copper, of which four are Roman, and seven American, struck before the revolution; the remainder are European, of different countries.

Geisinger (Capt. David, U. S. Navy) A collection of silver and copper coins, made in his Cruise in U. S. ship Peacock.

Godon (S., of U. S. Navy) A War Club, and some native Cloth from the Sandwich Islands, and a Neck Ornament from the Fejee islands, and a Hatchet from the Society Islands.

Hodgson (W. B.) Coins collected in Turkey and the Mediterranean.

Huntington (Wm Henry) Specimens of Fossil remains from the neighbourhood of Natchez.

Hopkinson (Jos.) Franklin's Original Electric Battery, with which he made his early experiments, which had become the property of his late son, D. Hopkinson.

Ingersoll (J. R.) Plan of a Ship Channel proposed round the Falls of Niagara, to connect the waters of Erie and Ontario, with seven Plans made in U. S. Topog. Bureau, under the direction of Capt. W. G. Williams, and reported to House of Rep. of United States April 1836;—also a Map showing the lands assigned to the emigrant Indians, west of Arkansas and Missouri, prepared at the Topog. Bureau of the United States, 1836.

Hassler (F. R.) Specimens of Zinc extracted from Picton copper and lead Mine, Perkioming, prepared by him, to form, with copper, brass for Weights and Measures of the United States, made under his directions.

Hitz (John) A collection of Minerals from Switzerland.

Kane (J. K.) A Circular Metallic Thermometer, made by Montandor, Washington City, 1835.

Mitchell (A. S.) Reference and Distance Map of the United States, published by Mitchell and Hinman. Philad., 1835. (See Donations for the Library.)

Naxara (M.) Three Medals, struck when Iturbide was declared emperor of Mexico. Mexico, 1822.

Nagy (C.) A valuable Collection of Minerals from Hungary and Germany.

Nuttal (T.) A Hat of grass, and bark Cordage, a Mat resembling those of the Sandwich

Nuttal (T.) *continued.*
Islands, a Bag of the Helonias Tenax, and bark Cordage from the Chinhook Indians, on Columbia river.
—— A War Club, from the Fejee Islands.
—— A common Marine Idol, for the head or stern of a canoe in the Sandwich Islands.
Parmentier (M.) Two English Coins of James I.
Roberts (E.) An engraved portrait of Joseph Roberts, a late member.
Rivinus (Florens, M.D.) Popple's large Map of Brit. Empire in N. America, with French and Spanish adjoining Settlements. London, 1733.
Sagra (R. de) A large Collection of Specimens of the different Woods of Cuba.
Short (Wm) Three large Book Cases.
Short (C. W.) An Herbarium of Kentucky and the Western country (in addition to a previous donation of specimens especially of Hexandria and Triandria), containing Five hundred and thirty-five Specimens, two hundred and ninety-five Species, two hundred and ten Genera.
Taylor (R. C.) Specimens of Copper, Lead and Zinc Ores, from Picton Mines, Perkioming, Pennsylvania.
Watmough (Col.) Chart of Narraganset Bay, surveyed by order of the Government of the United States.
Walter (T. U.) Lithog. Plan of Girard College, now building, of which he is architect.
Wallich (N.) An interesting Collection of Seeds from the Botanical Garden of Calcutta.

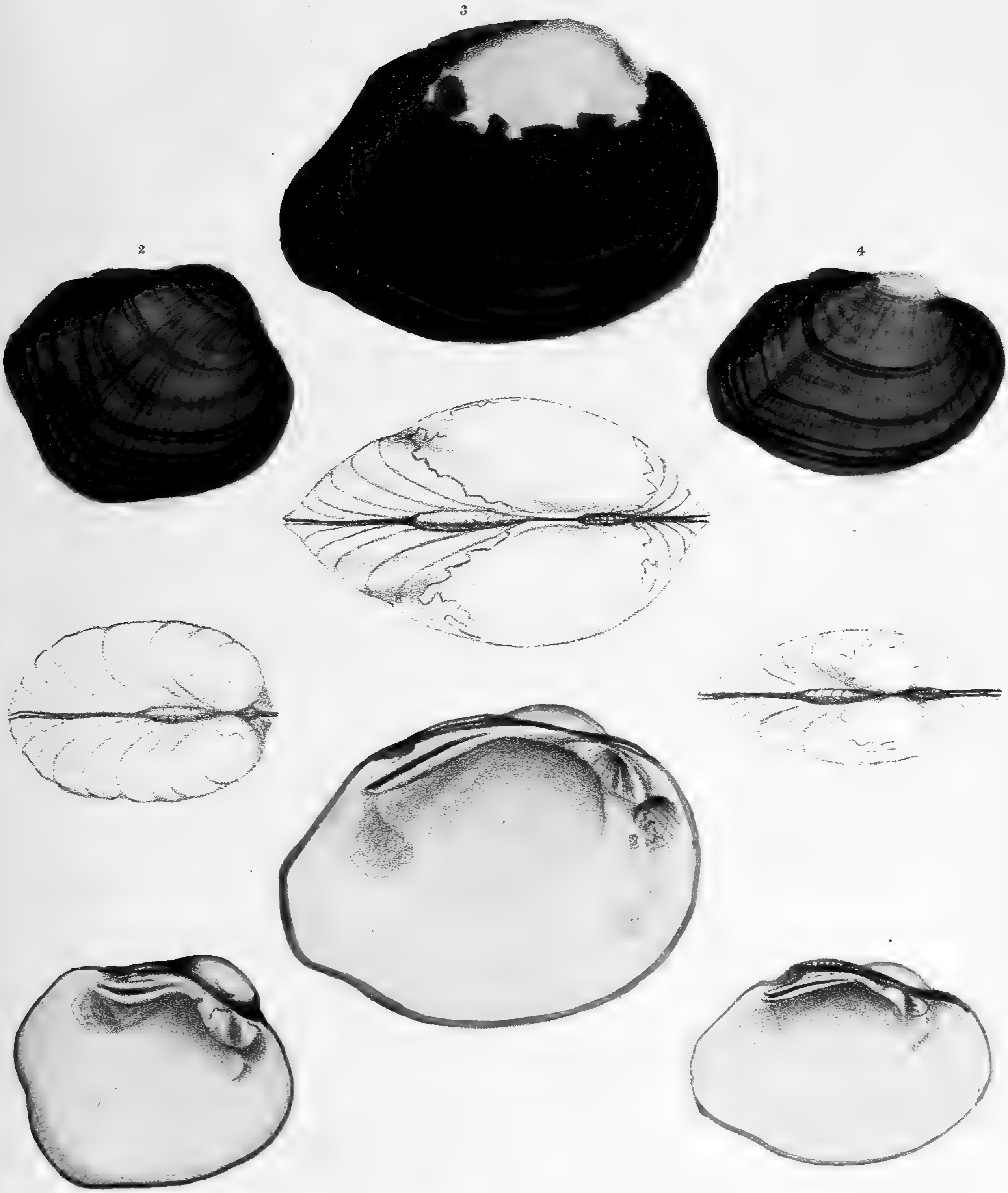
Other additions were made to our Minerals by Dr James Mease, John Roe, B. Nelson, Henry Blight, of Bristol (G. B.), John Vaughan and James Pedder, and to our shells by John Vaughan.

THE END.

Drawn by J Drayton

Unio Nicklinianus

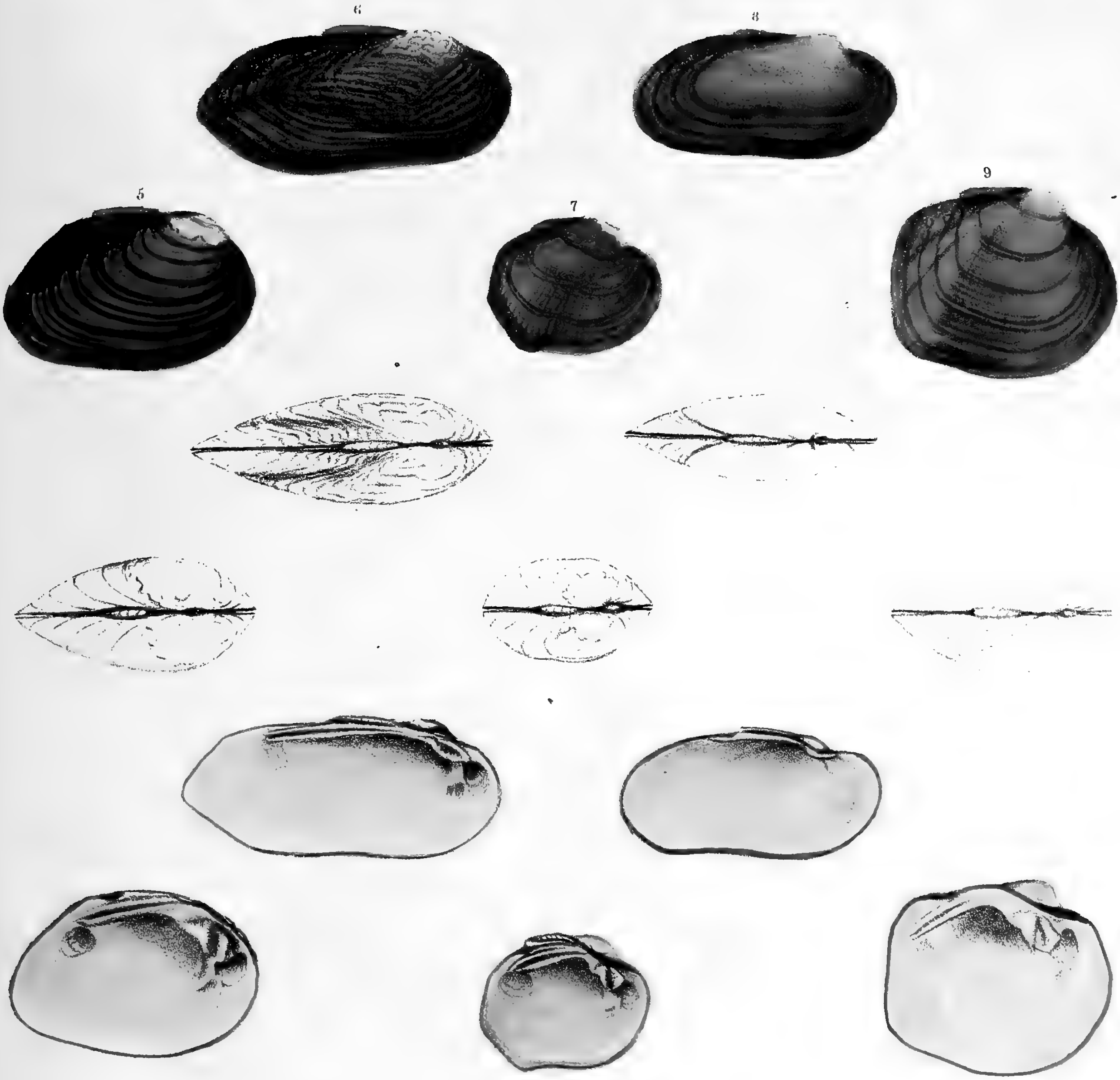
PL. II Vol. 5



Unio capillaris. *Unio subglobosus.* *Unio capsæformis.*

Drawn by J. Drayton.

PL. III Vol. 5.

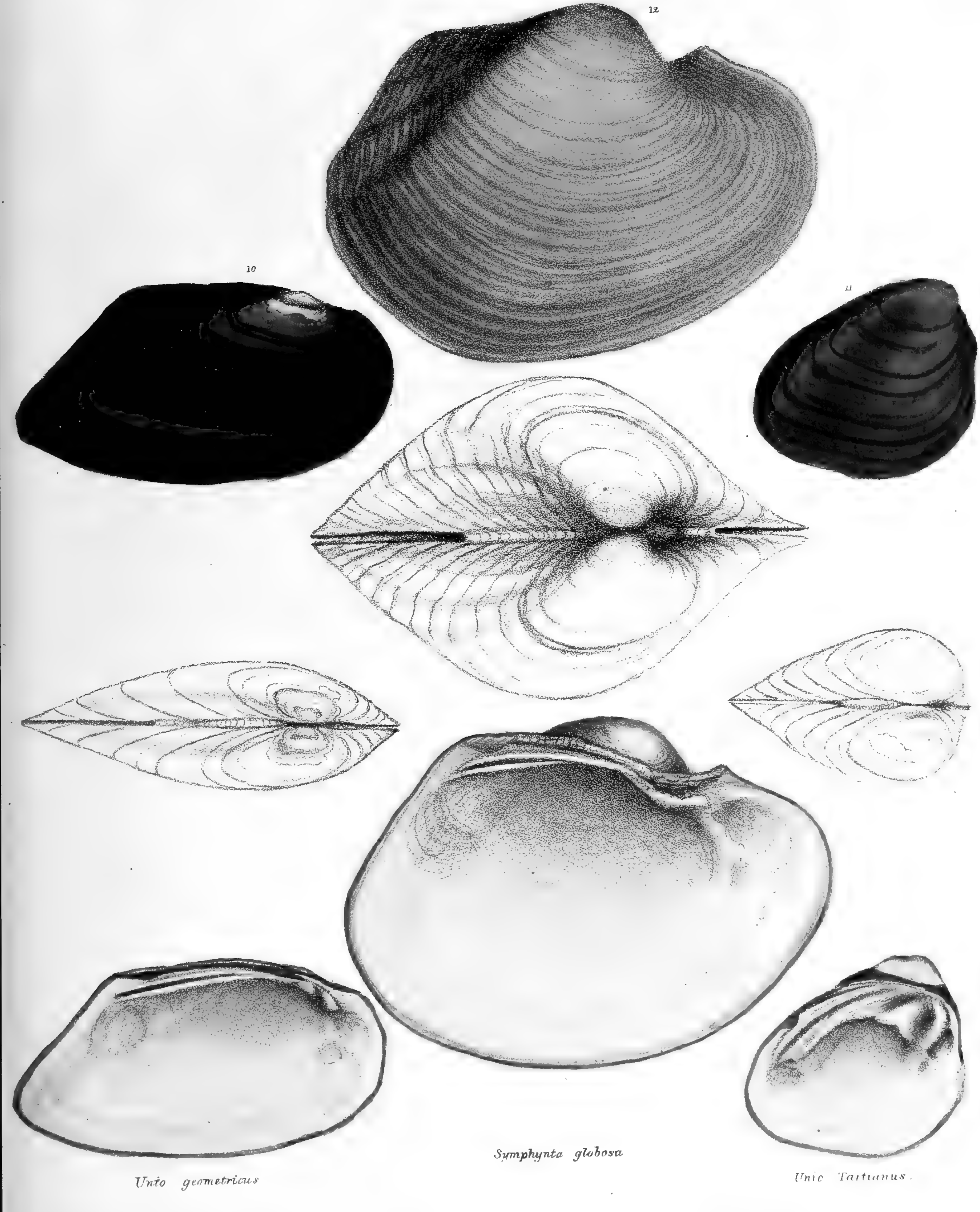


Unio Murchisonianus. *Unio Hildrethianus.*

Unio Ravanelianus. *Unio Haysianus.* *Unio Schoolcraftensis*

Drawn by

PL. IV Vol 5.

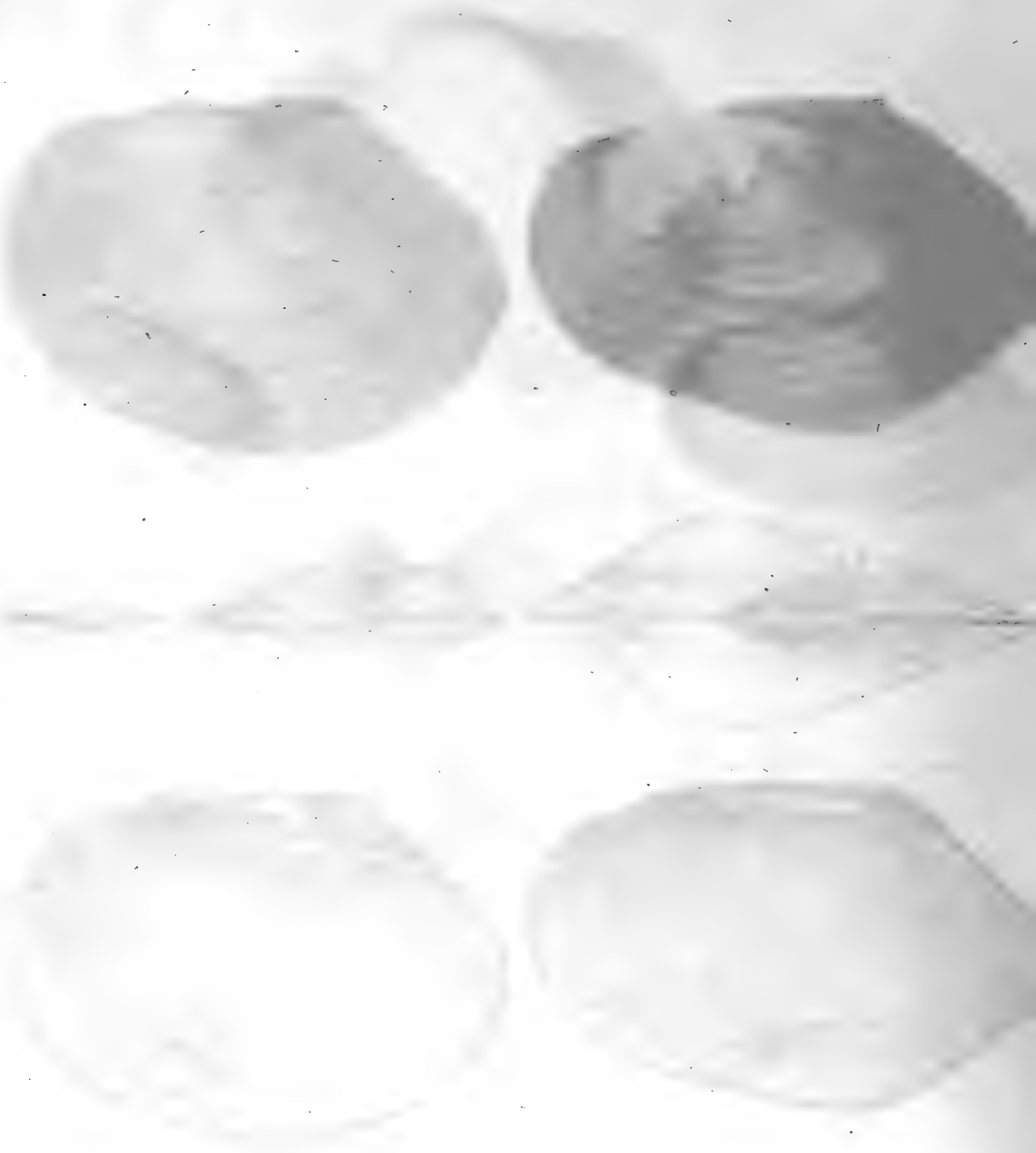


Unio geometricus

Symphynta globosa

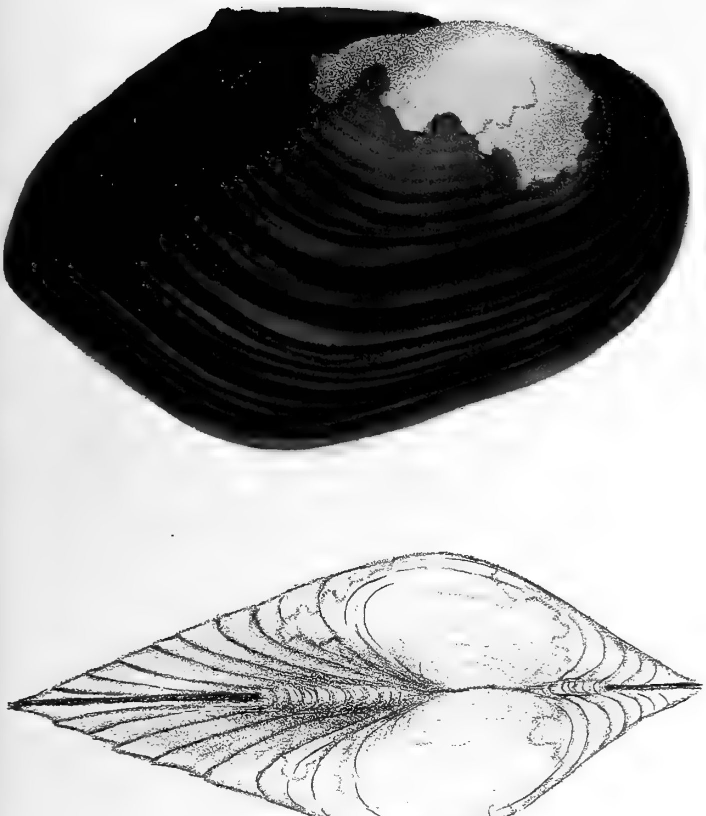
Unio Taitianus.

Drawn by J Drayton.



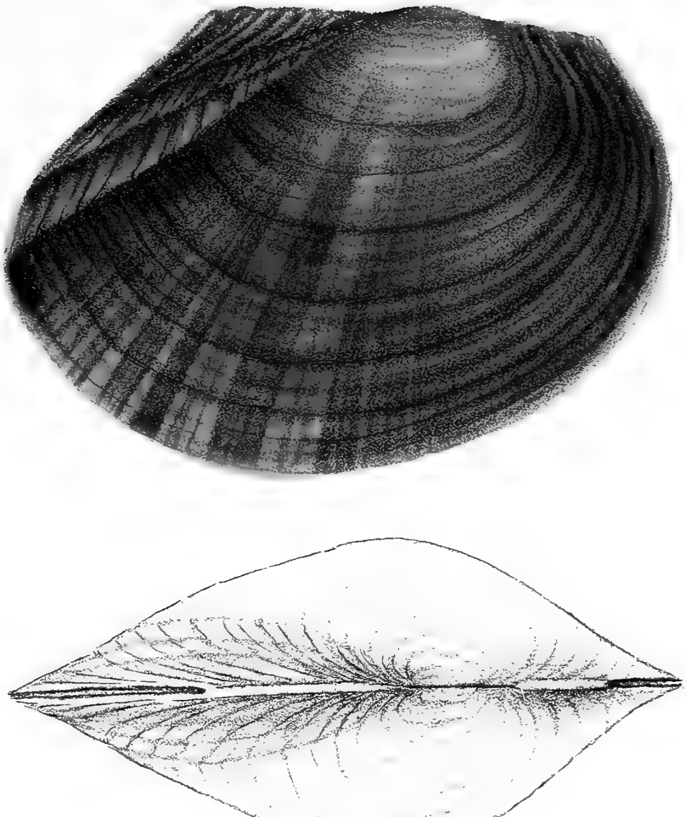
PL. V. Vol. 5.

13



Symphynota Woodiana.

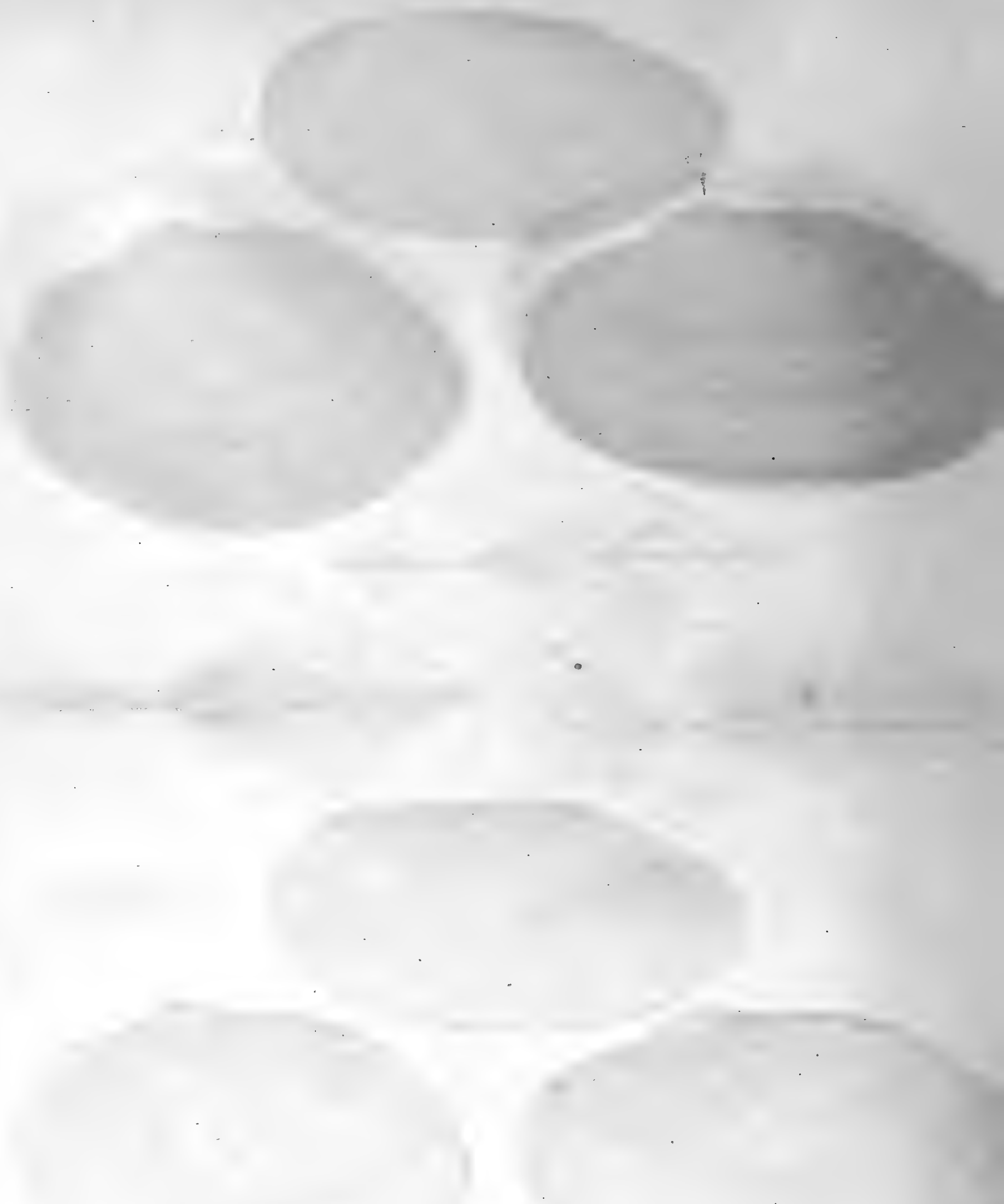
14

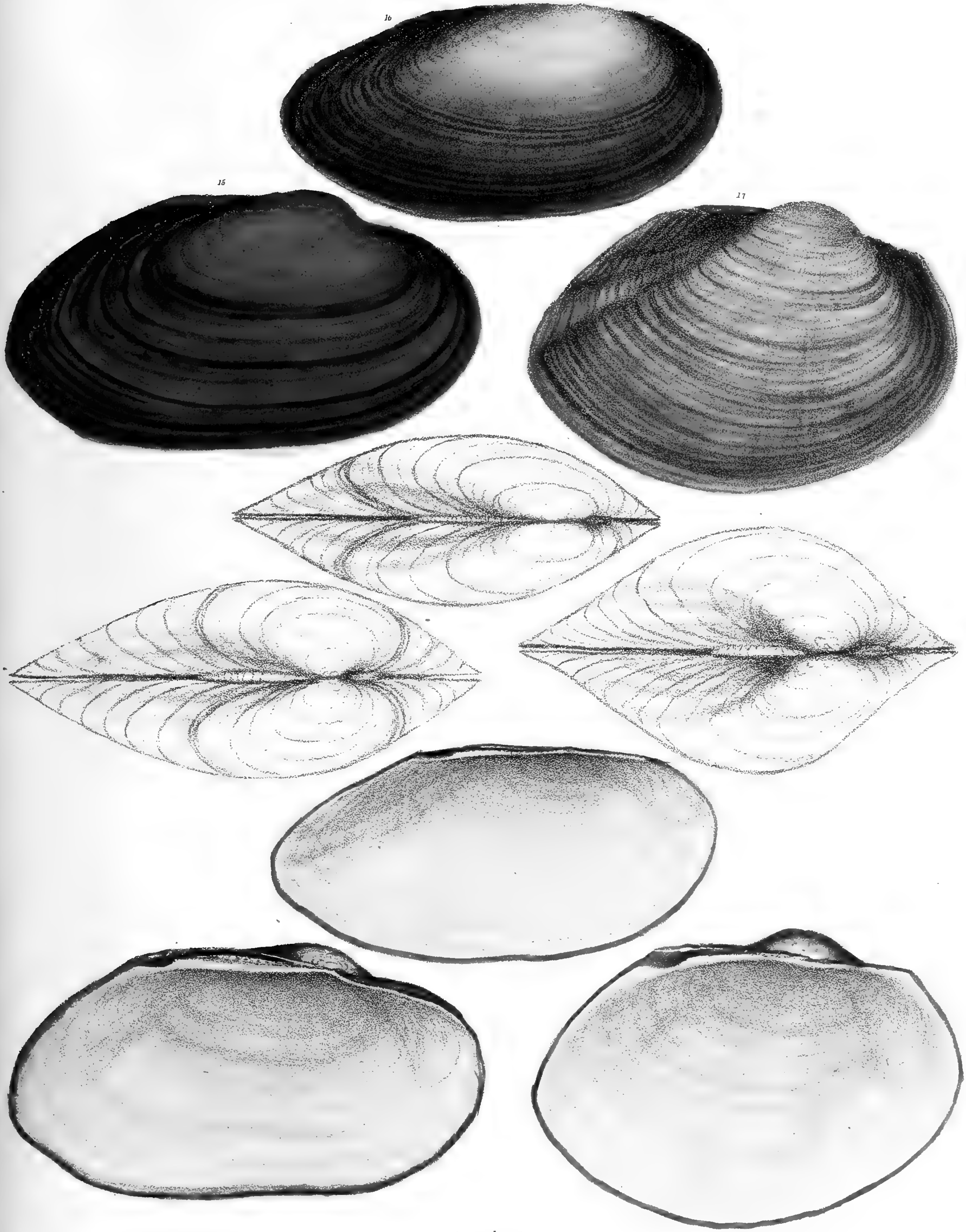


Symphynota magnifica.

Brown's Lith

Drawn by J. Drayton.





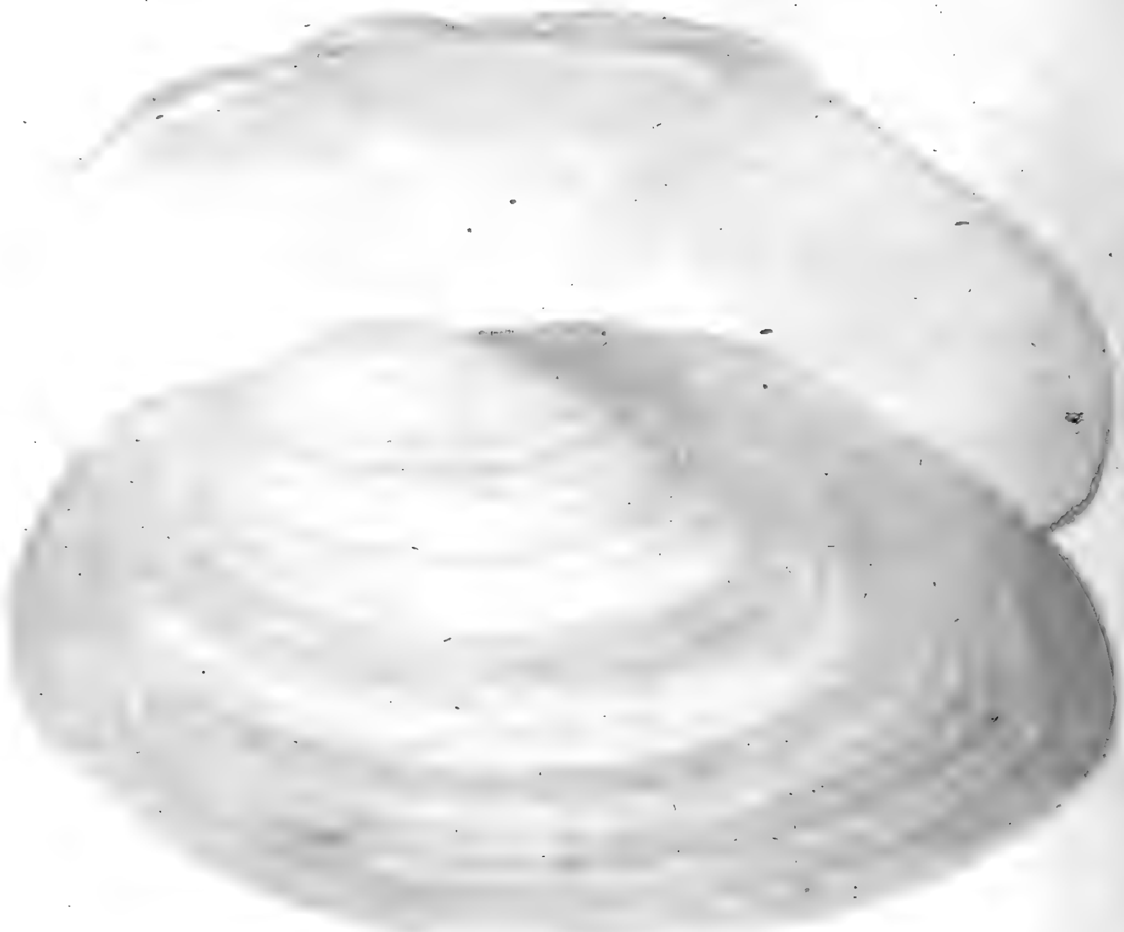
Anadonta Ferussaciana.

Anadonta incerta.

Anadonta Stewartiana.

Drawn on stone by J. Drayton.

Lith. by M. E. D. Brown.



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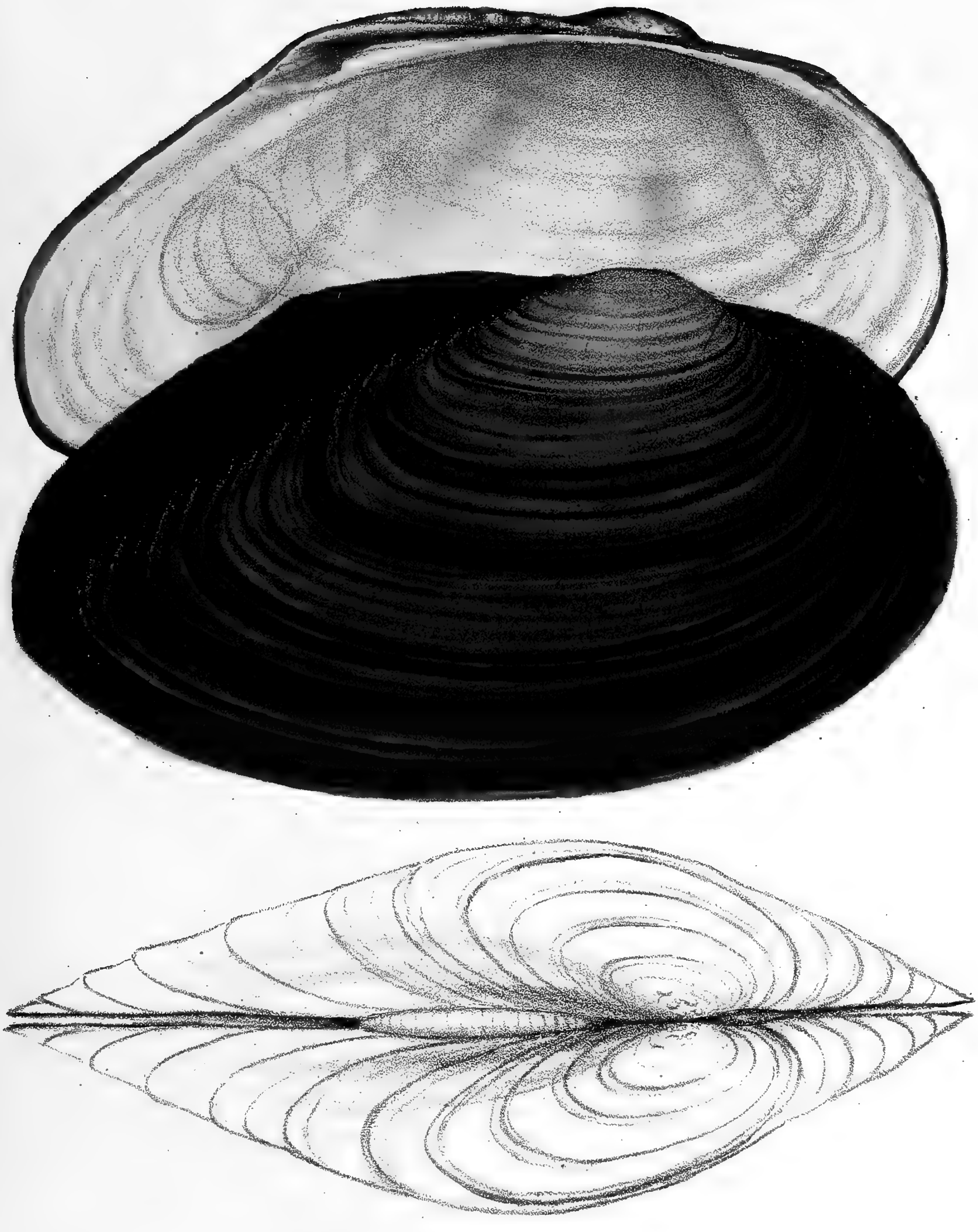
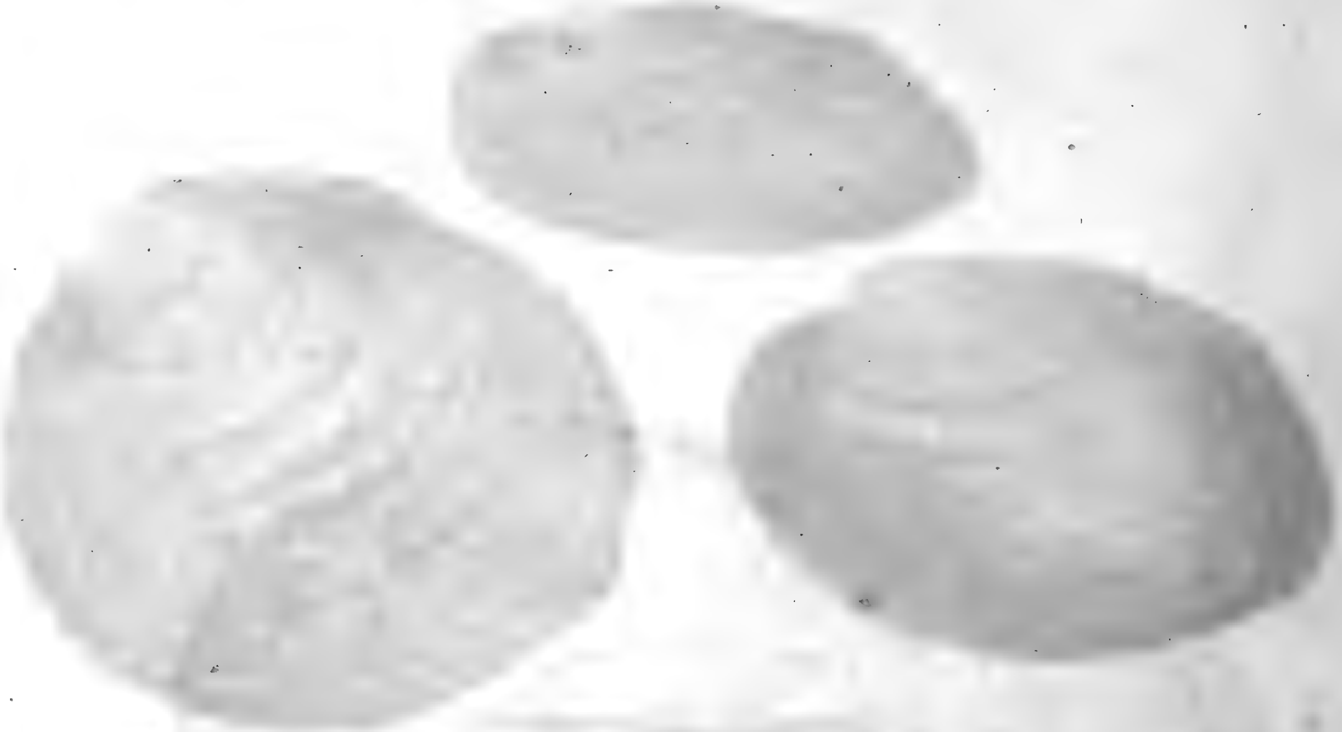
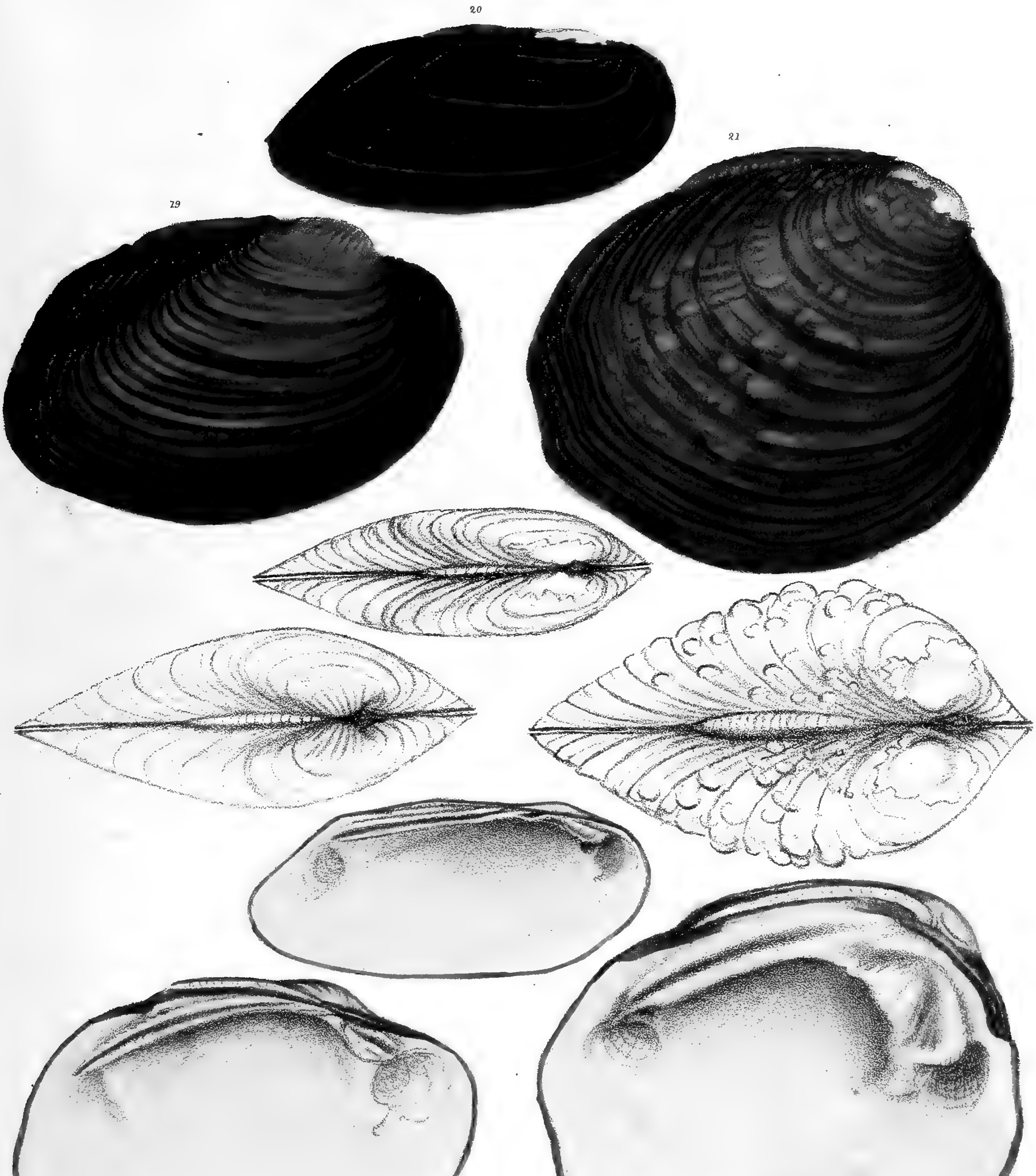


Anadonta pluna.

Brown's Lith.

Drawn by J. Drayton





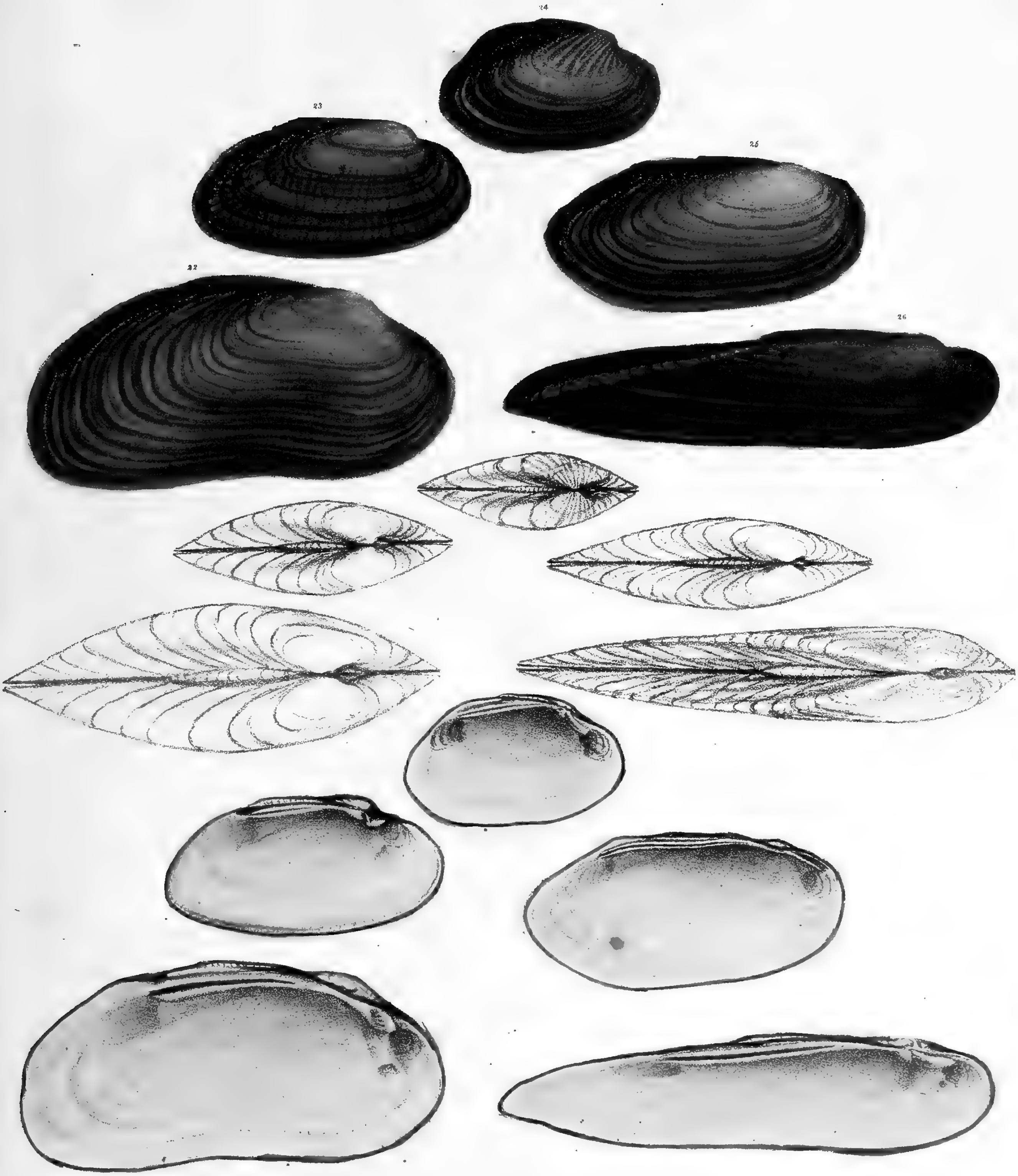
Unio parallelopipedon.

Unio lacteolus.

Unio Cooperianus.

Drawn on stone by J. Drayton.

Brown's Lith.



Unio emarginatus. *Unio divaricatus.* *Unio Grayanus.*

Unio Conradicus. *Unio Corrianus.*

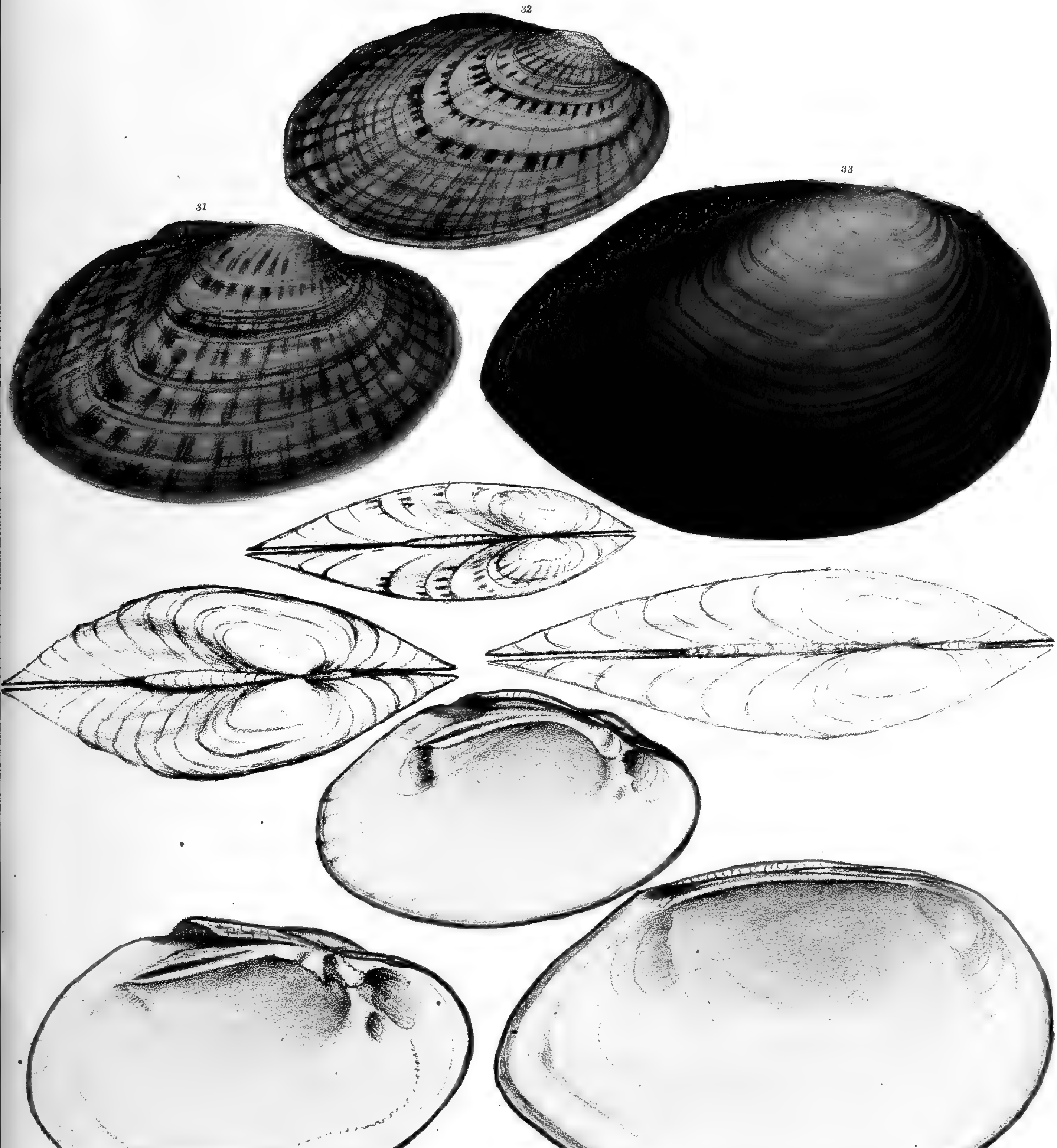
Drawn on stone by J. Drayton. Brown's Lith.

Unio Sowerbianus. *Unio dromus.*

Unio Burroughianus. *Unio Troostensis.*

Drawn by J. Drayton. Bowen's Lith

PL.ᵉ XI Vol.5.



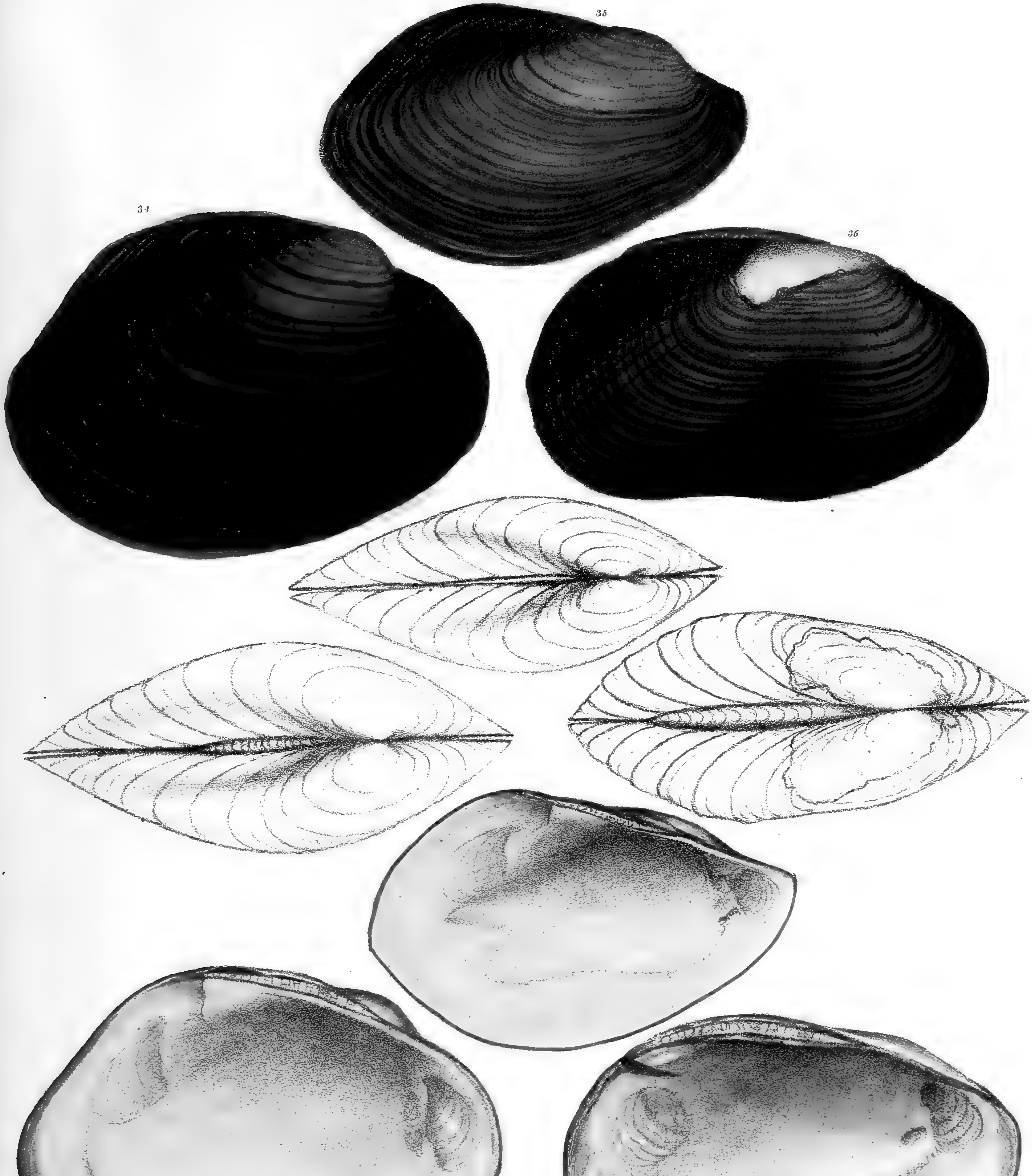
Unio pictus.

Unio perdix.

Symphynota discoide.

Drawn by J. Drayton.

Brown's Lith

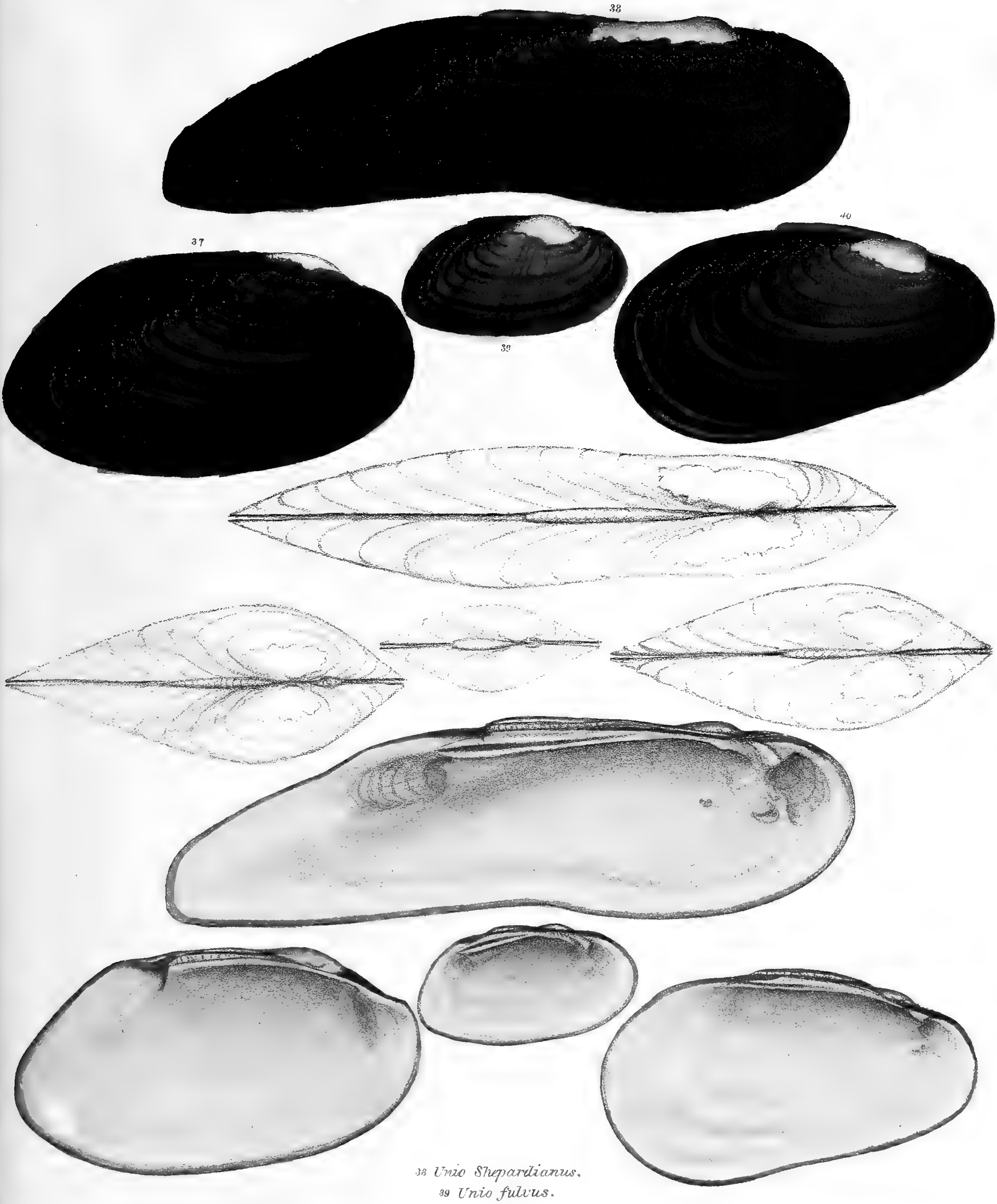


Anodonta Blainvilliana.

Anodonta lato-marginata.

Anodonta tenebricosa.

Drawn by J. Drayton.



38 *Unio Shepardianus.*
39 *Unio fulvus.*

Anodonta Mortoniana.

Unio modiolaformis.

Drawn by J. Drayton.

Unio Paranensis.

Unio Kirtlandianus.

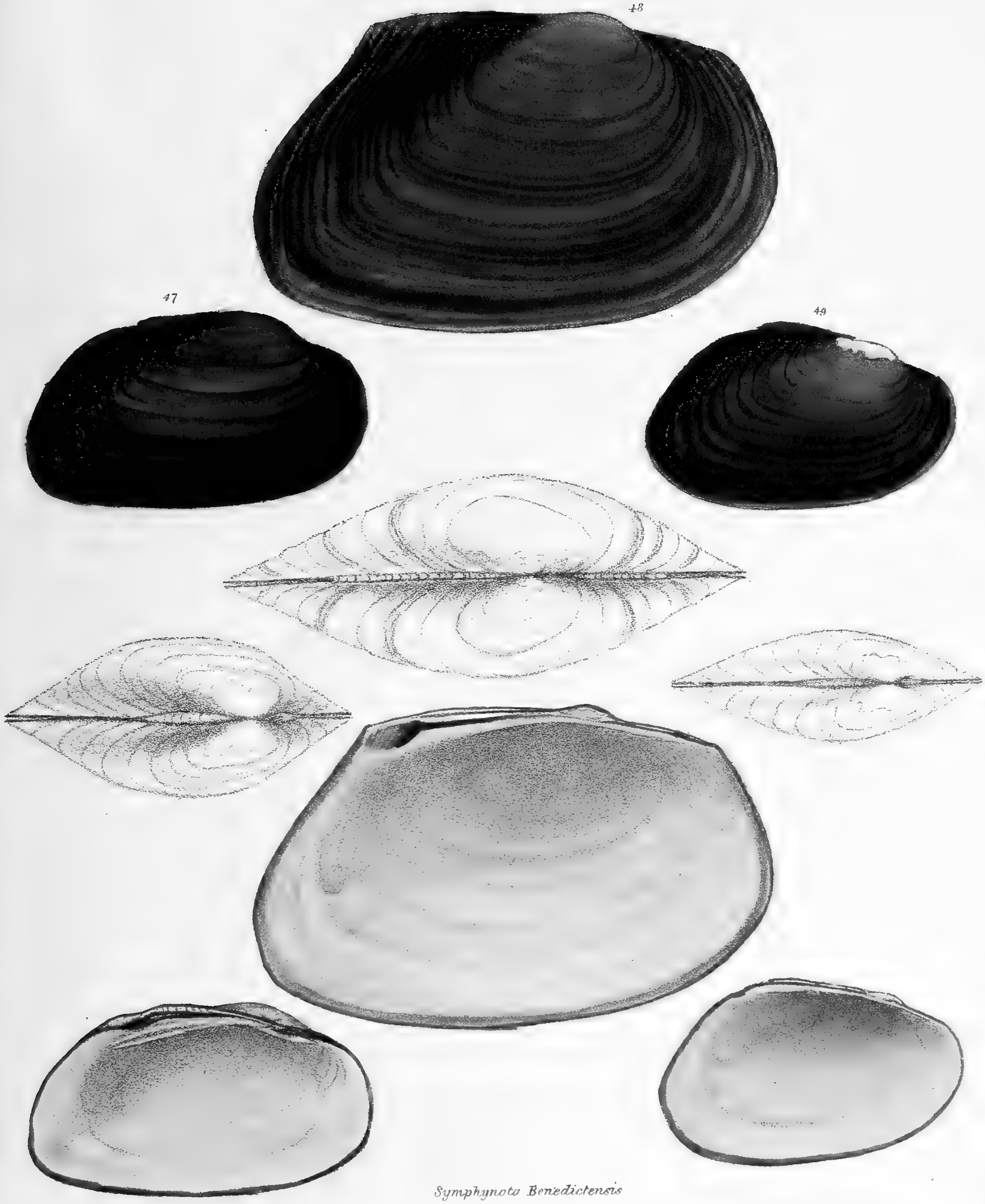
Unio Nashvillianus.

Drawn by J. Drayton.

Unio camelus.

Unio Blandingianus.

Unio Griffithianus.

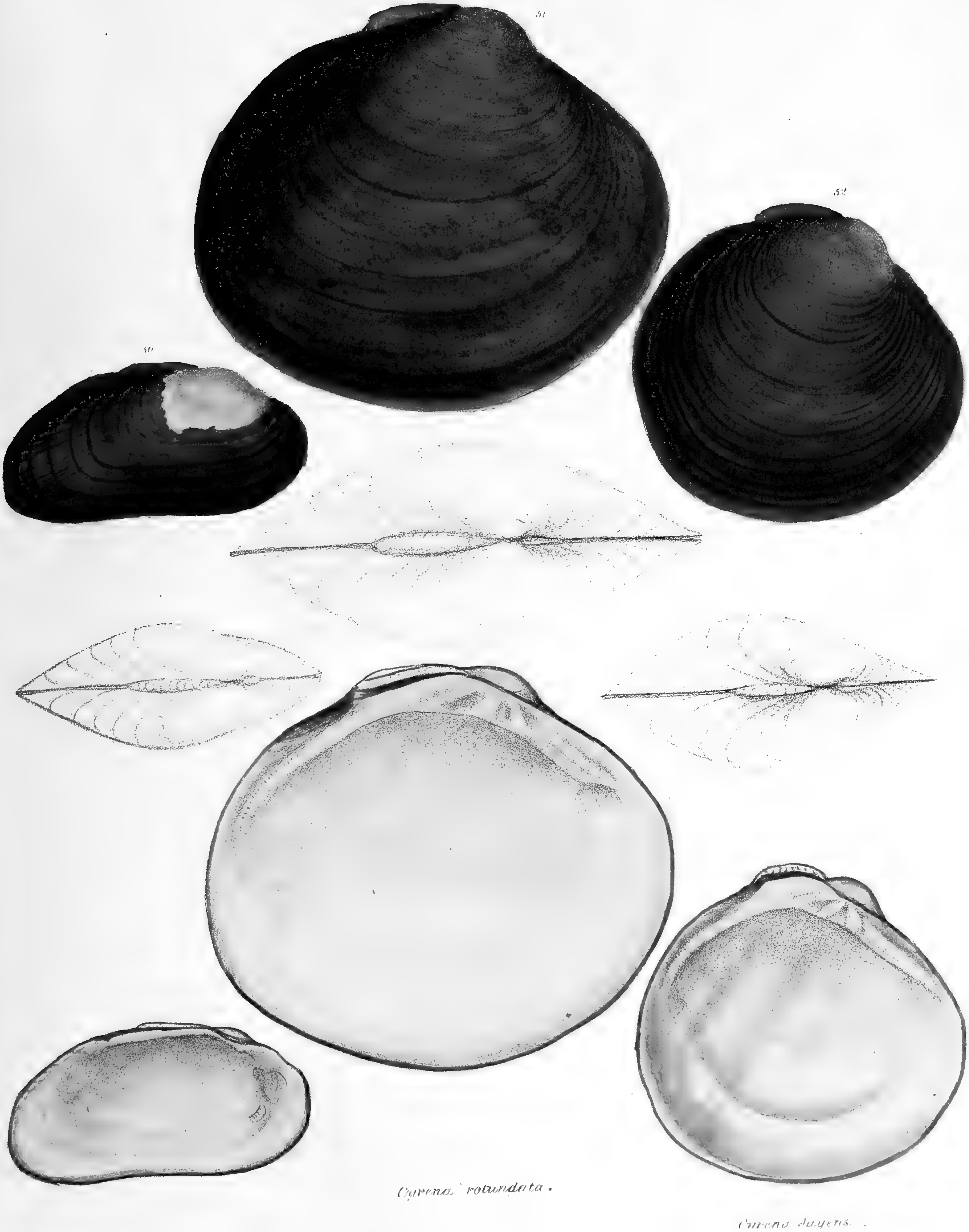


Symphynota Benedictensis

Anodonta Burroughiana.

Unio confertus.

Drawn by J. Drayton

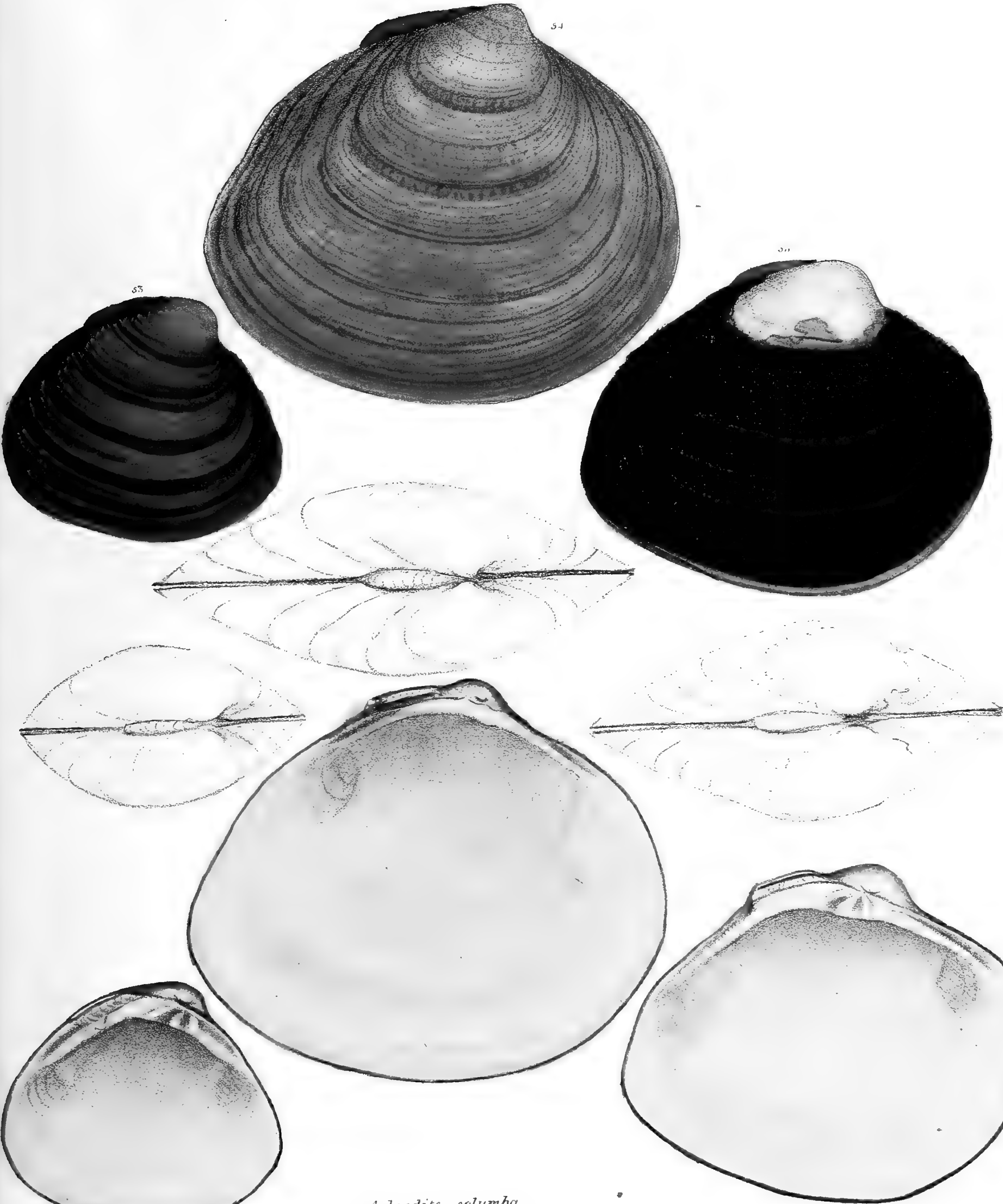


Cyrena rotundata.

Cyrena Jayens.

Margaritana Raveneliana.

Drawn by J. Drayton

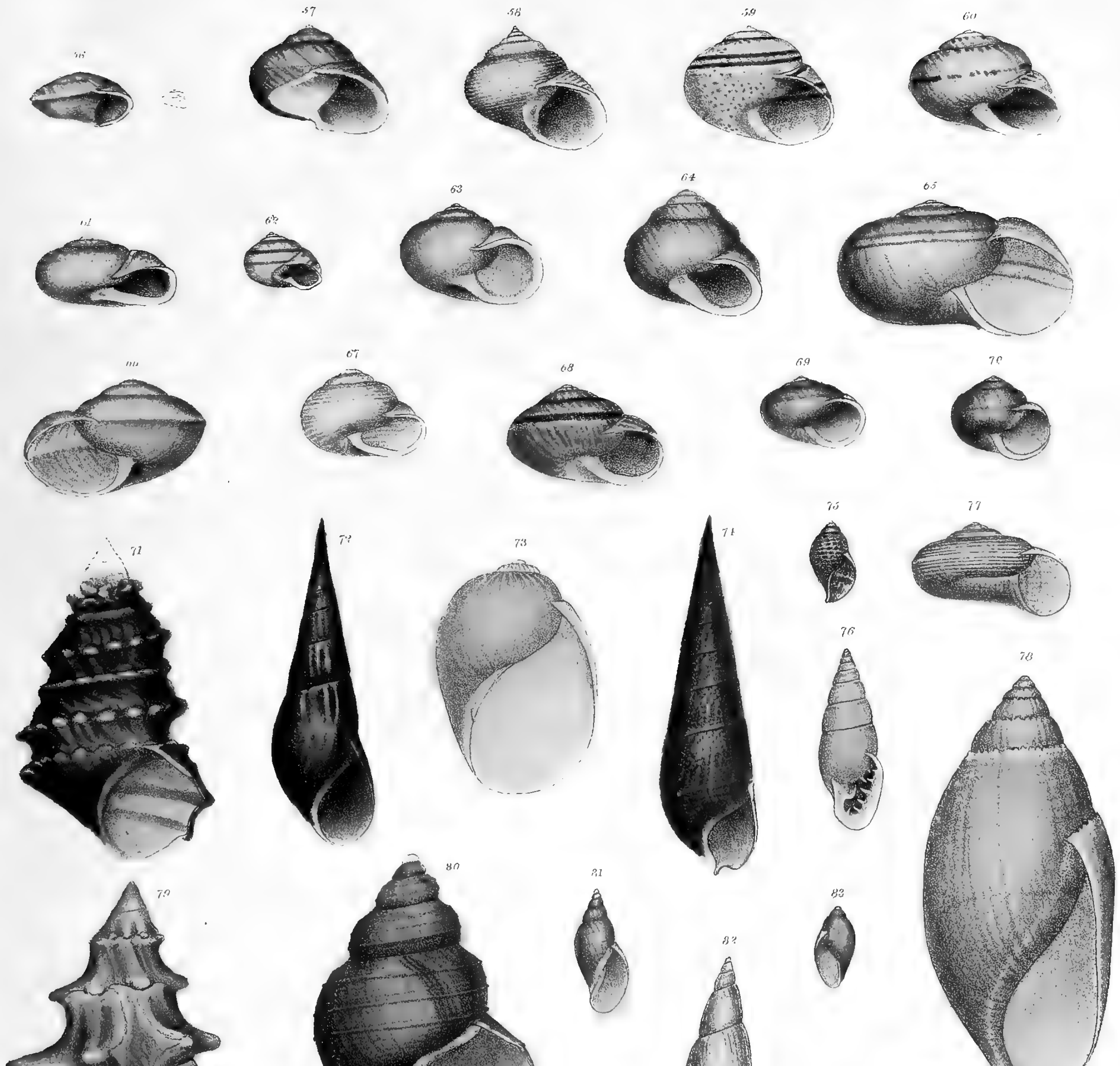


Aphrodite columba

Cyrena turgida.

Cyrena Woodiana.

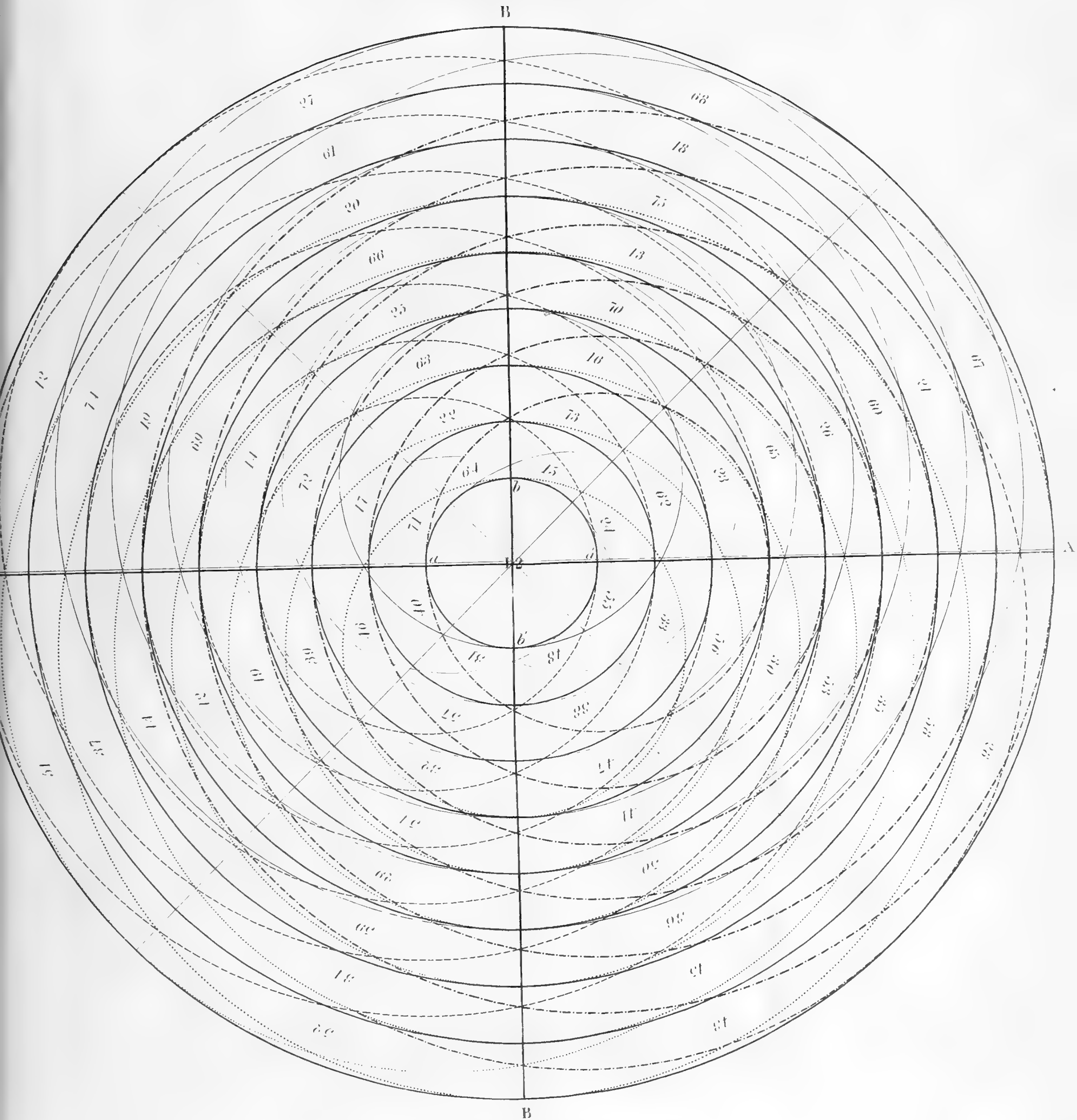
Drawn by J. Drayton.

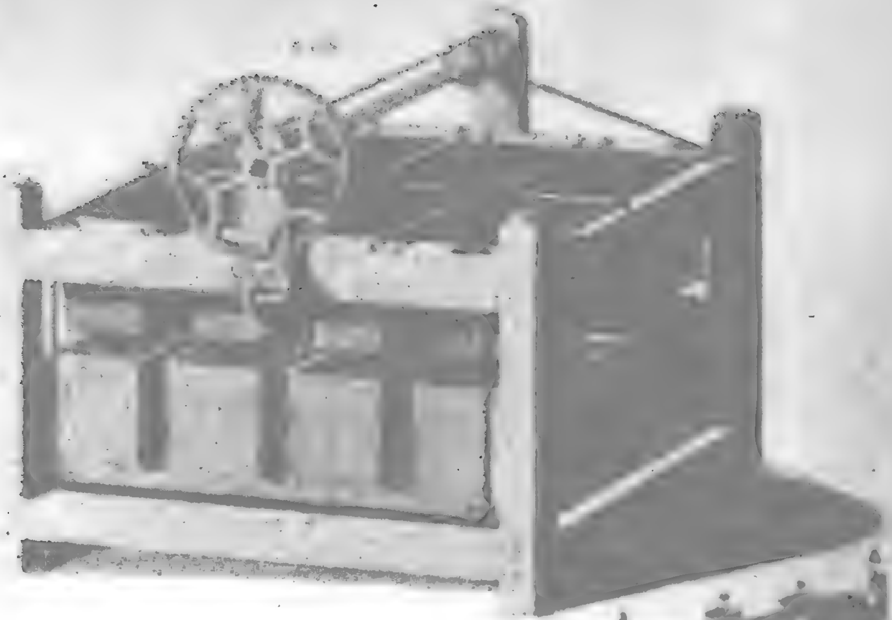


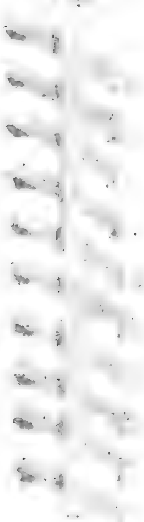
56 *Helicina* .... *lens*
57 ,, ... *pulcherrima*
58 ,, ... *virginea*
59 *Helix* ... *muscarum*
60 ,, ... *purpuragula*
61 ,, ... *ovum reguli*
62 ,, ... *monodonta*
63 ,, ... *cyclostomopsis*
64 *Helix* ... *mamilla*
65 ,, ... *diaphana*
66 ,, *Himalana*
67 ,, *vesica*
68 ,, ... *cincta*
69 ,, ... *Woodiana*
70 ,, ... *globula*
71 *Paludina* *bi-monilifera*
72 *Melania* .. *aculeus*
73 *Lymnaea* ..... *imperialis*
74 *Melanopsis* .. *princeps*
75 ,, ... *maculata*
76 *Auricula* *fuscagula*
77 *Cyclostoma* . *striata*
78 *Achatina* *Vanuxemensis*
79 *Io.* *spinosa*
80 *Paludina* *Burroughana*
81 *Lymnaea* *acuta*
82 ,, *exilis*
83 *Physa* ..... *elliptica*
84 *Ampullaria* *Hopetonensis*
85 *Paludina* . *Georgiana*
86 *Succinea* *retusa*

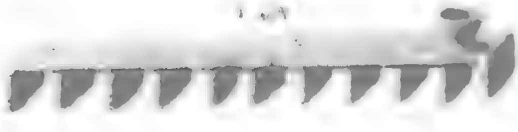
Drawn by J. Drayton


Fig 2
Fig 1
Drawn on stone by J. Drayton
Page 134


B
A
B







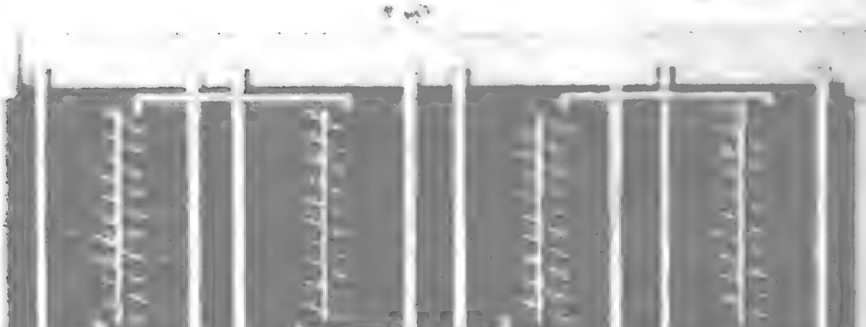


Fig 1.

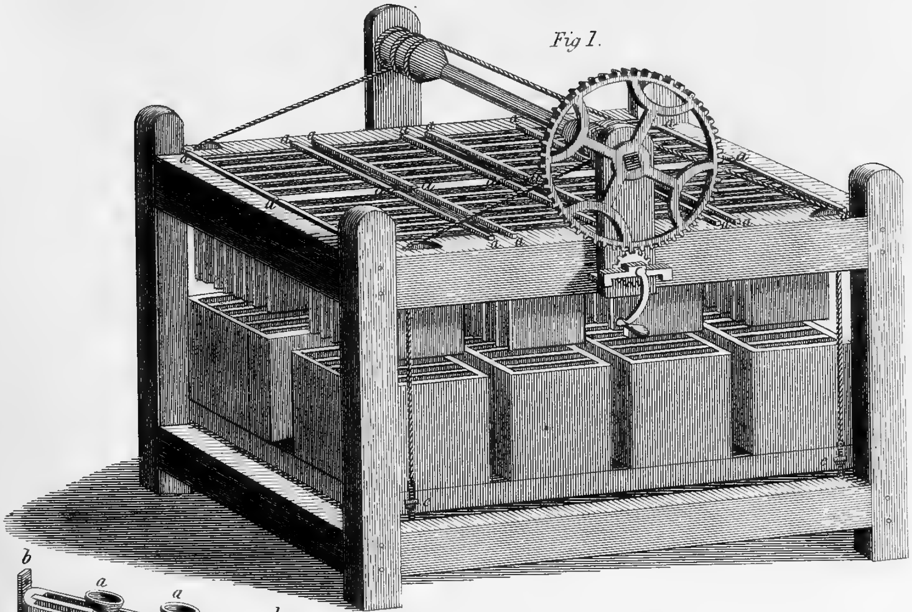


Fig 3.

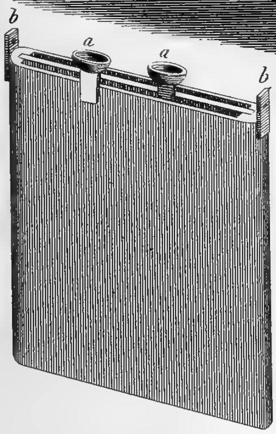


Fig 4.

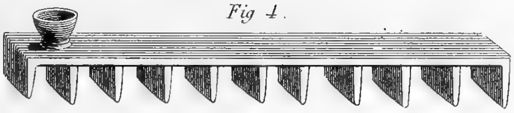


Fig 5.

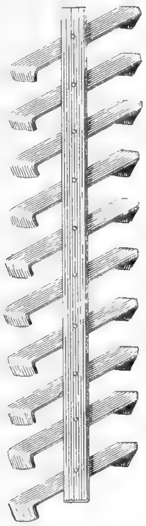
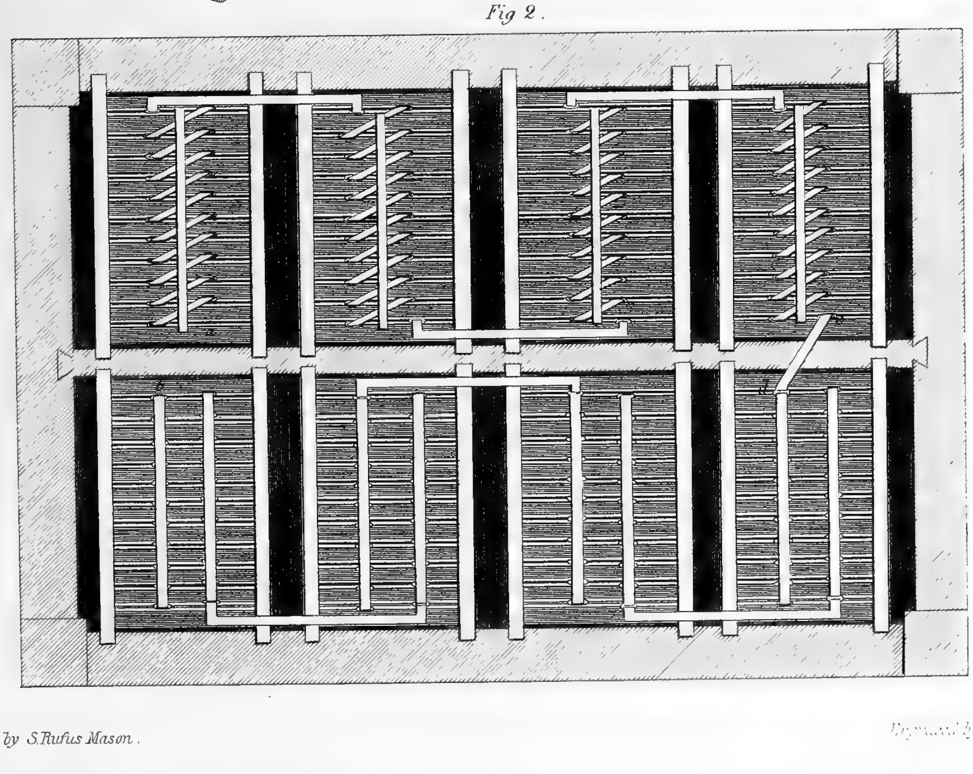


Fig 2.



Drawn by S. Rufus Mason.

Engraved by J. Yeager

PLATE XVIII.

Fig. 1.

WOOD of Mr M. S. GARRETSON.

Scale as of fig 4.

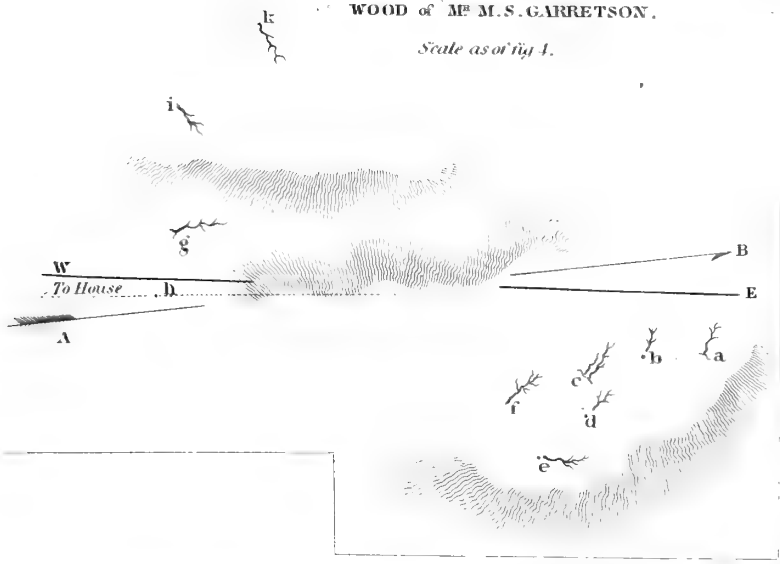


Fig. 2.

OUT HOUSE of Mr D. POLHEMUS.

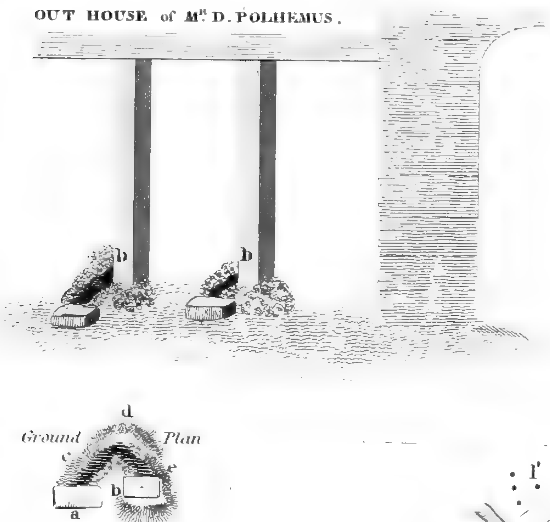


Fig. 4.

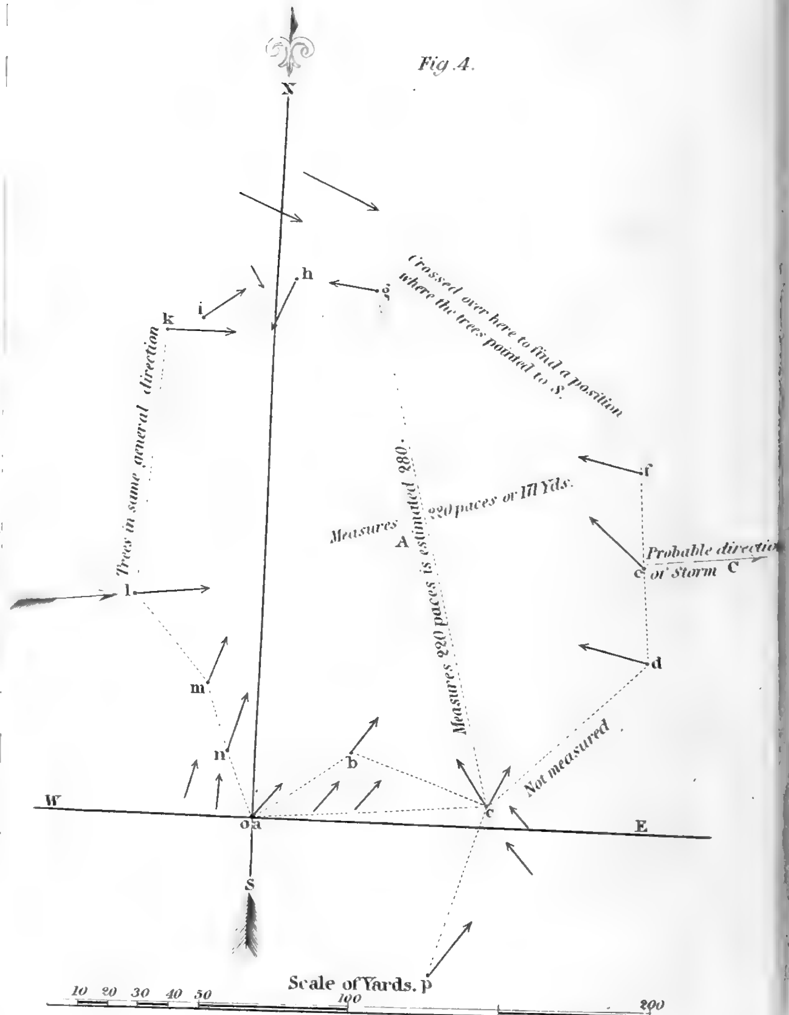


Fig 3.

DWELLING &c. and ORCHARD of Mr D. POLHEMUS.

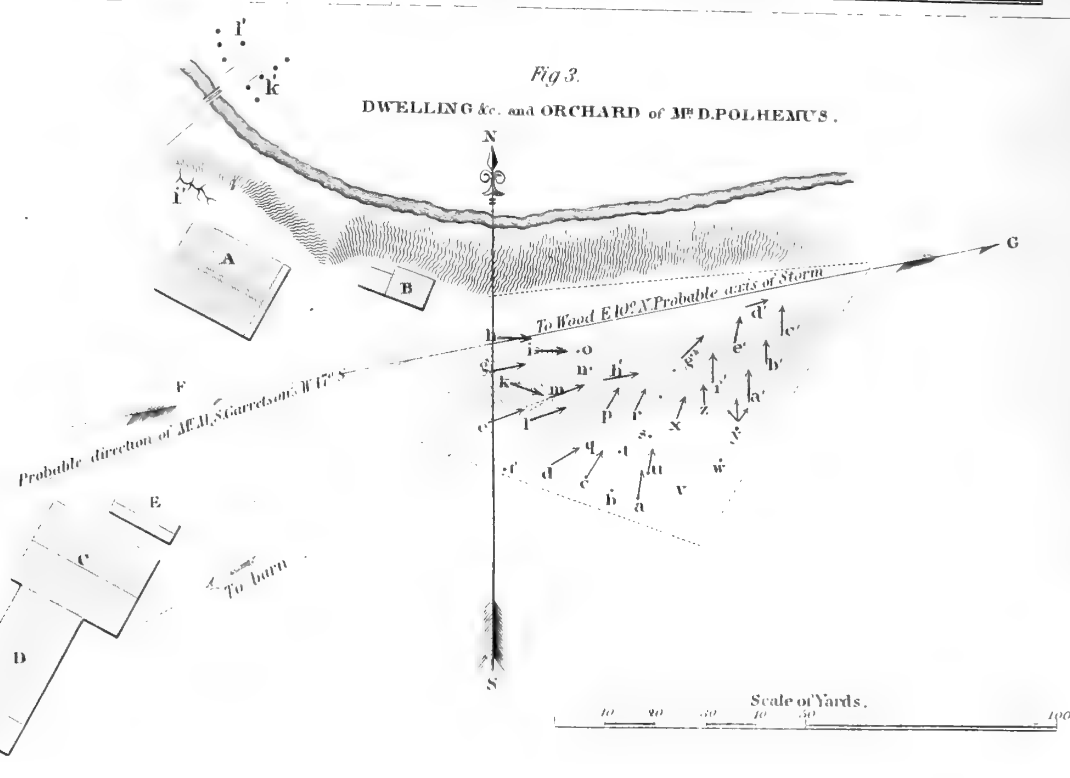


PLATE XXIV.

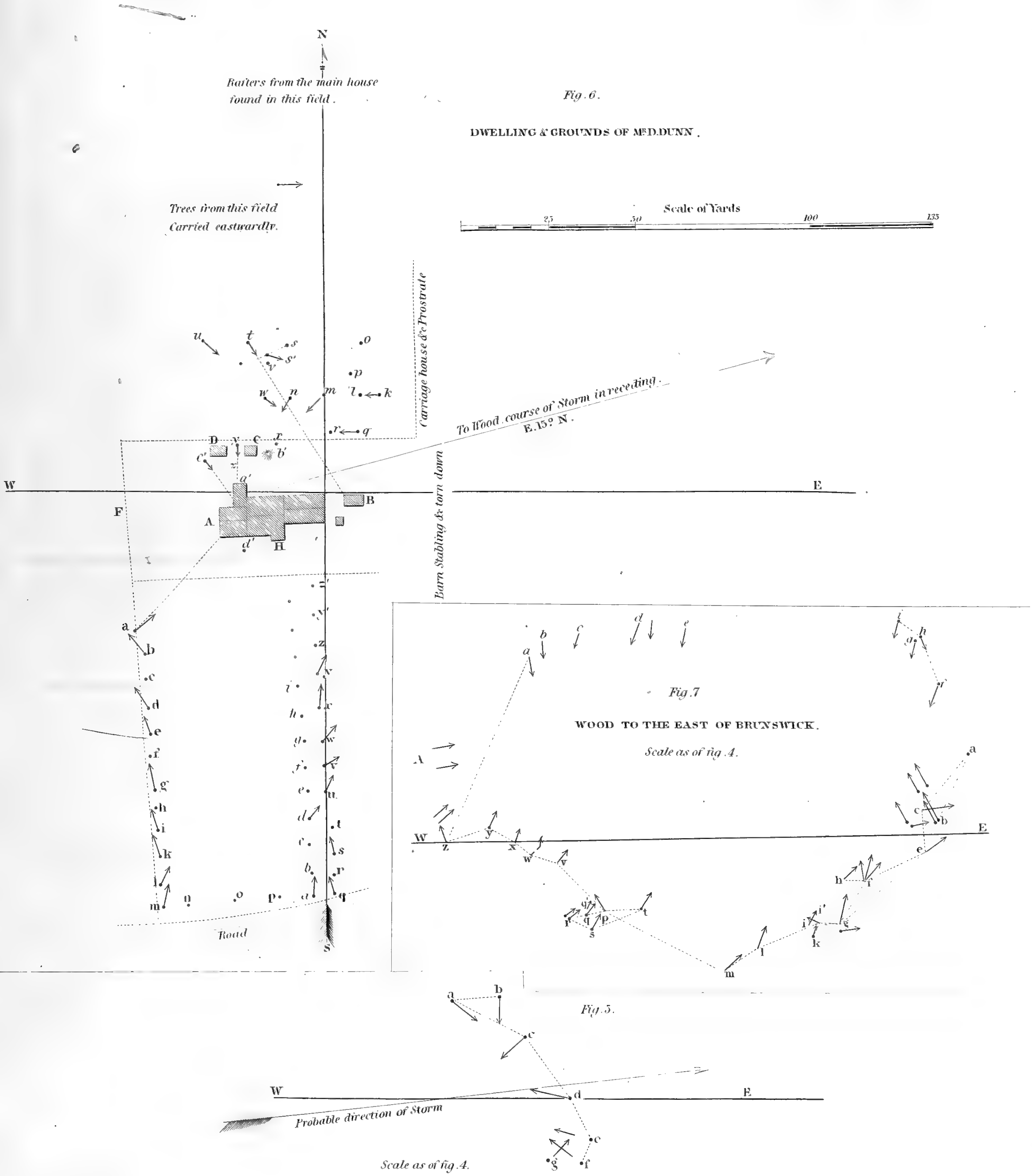
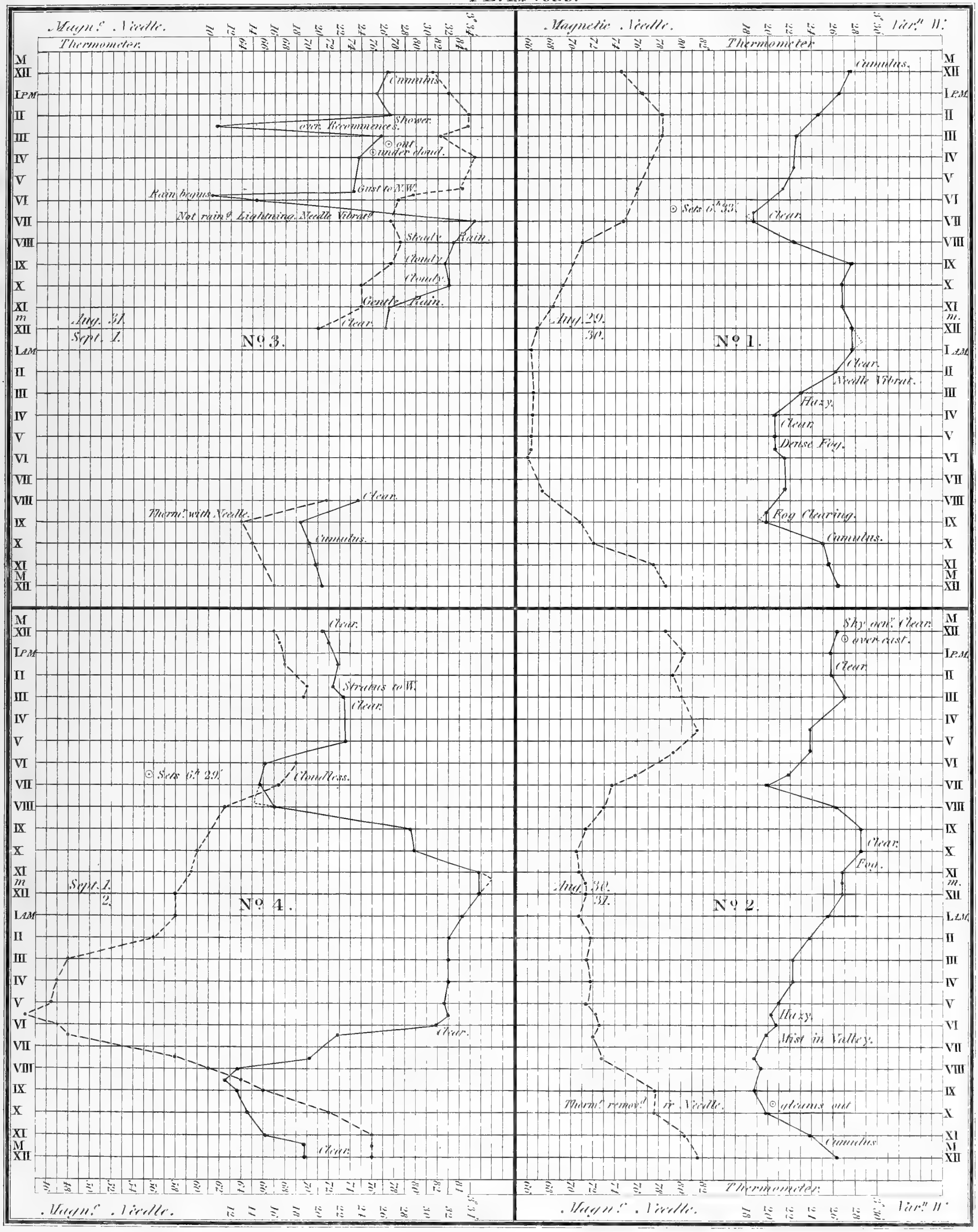
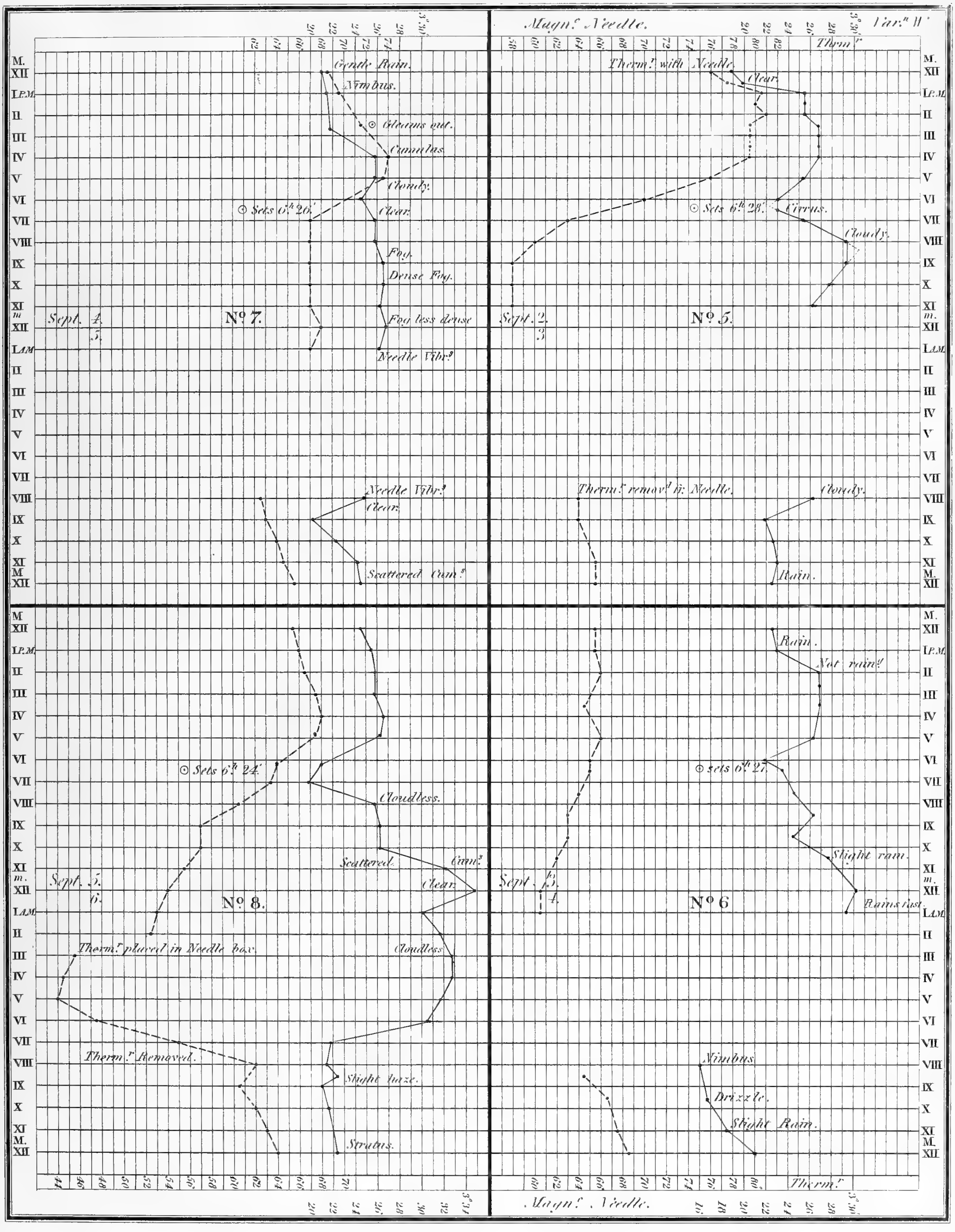
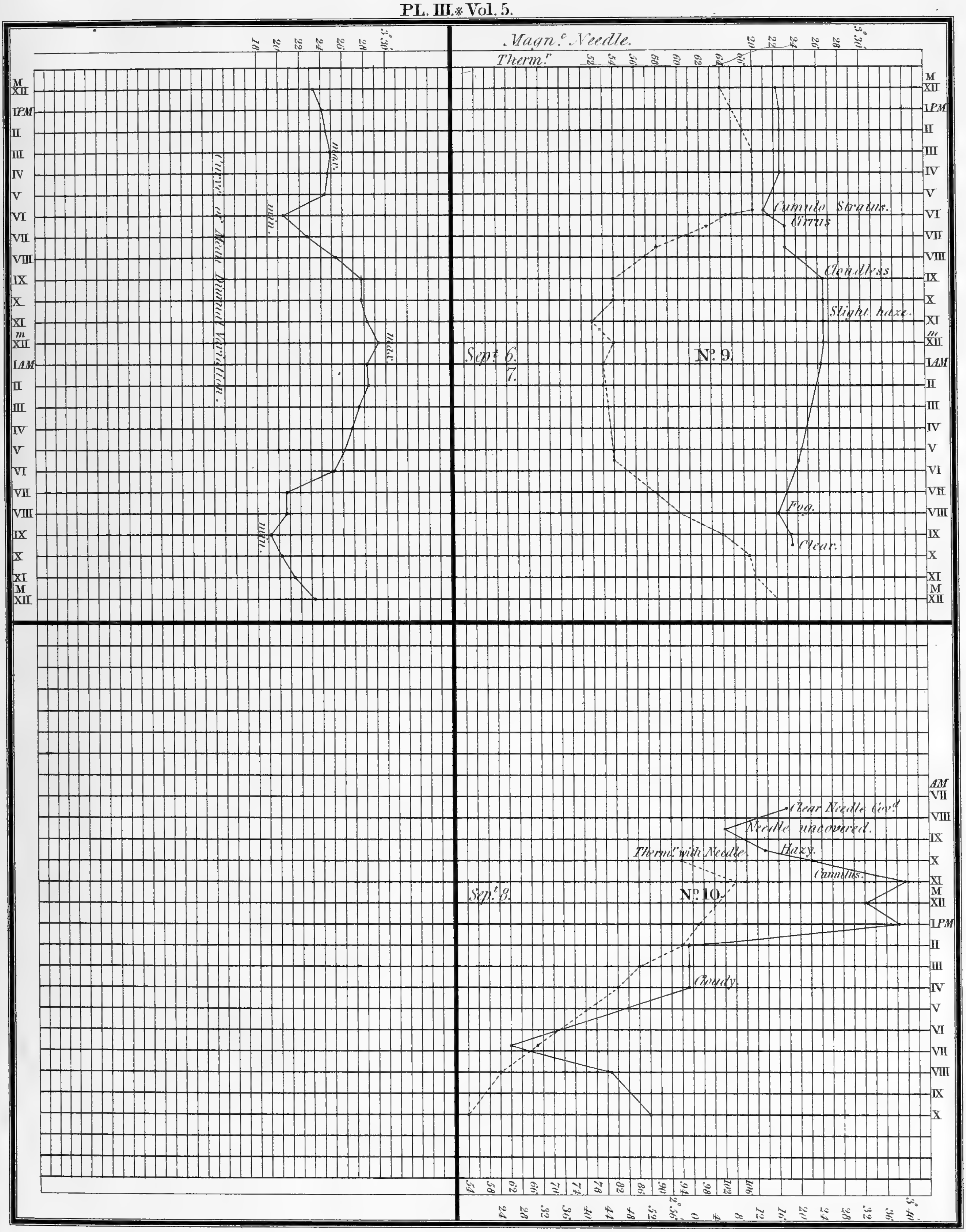


Fig. 6.
DWELLING & GROUNDS OF Mr. D. DUNN.
Scale of Yards
25
50
100
135
N
S
W
E
Rafters from the main house found in this field.
Trees from this field Carried eastwardly.
Carriage house &c. Prostrate
Barn Stabling &c. torn down
To Wood. course of Storm in receding.
E. 15° N.
Road
Fig. 7
WOOD TO THE EAST OF BRUNSWICK.
Scale as of fig. 4.
Fig. 5.
Probable direction of Storm
Scale as of fig. 4.


No. 1.
Aug. 29.
30.
No. 2.
Aug. 30.
31.
No. 3.
Aug. 31.
Sept. 1.
No. 4.
Sept. 1.
2.
Magnetic Needle.
Thermometer.
Var.n W.
Cumulus.
Shower.
over. Recommences.
⊙ out.
⊙ under cloud.
Gust to N.W.
Rain begins.
Not rain.g Lightning. Needle Vibrat.g
Steady Rain.
Cloudy.
Gentle Rain.
Clear.
Therm.r with Needle.
⊙ Sets 6h. 33.
Needle Vibrat.
Hazy.
Dense Fog.
Fog Clearing.
Stratus to W.
⊙ Sets 6h. 29.
Cloudless.
Sky gen.l Clear.
⊙ over-cast.
Fog.
Mist in Valley.
Therm.r remov.d fr. Needle.
⊙ gleams out.


Magn^c Needle.
Var.^n W.
Therm.^r
Therm.^r with Needle.
Gentle Rain.
Nimbus.
Gleams out.
Cumulus.
Cloudy.
Sets 6^h 26'.
Clear.
Fog.
Dense Fog.
Fog less dense
Needle Vibr.^g
Sept. 4. 5.
Nº 7.
Clear.
Sets 6^h 28'.
Cirrus.
Cloudy.
Sept. 2. 3
Nº 5.
Needle Vibr.^g
Clear.
Scattered Cum.^s
Therm.^r remov.^d fr. Needle.
Cloudy.
Rain.
Rain.
Not rain.^g
Sets 6^h 24'.
Cloudless.
Scattered.
Cum.^s
Clear.
Sept. 5. 6.
Nº 8.
Therm.^r placed in Needle box.
Cloudless.
Therm.^r Removed.
Slight haze.
Stratus.
sets 6^h 27'.
Slight rain.
Sept. 3. 4.
Nº 6
Rains fast.
Nimbus.
Drizzle.
Slight Rain.
Magn^c Needle.
Therm.^r


Magn.c Needle.
Therm.r
Curve of Mean Diurnal Variation.
max.
min.
Sep.t 6.
7.
N.o 9.
Cumulo Stratus.
Cirrus
Cloudless
Slight haze.
Fog.
Clear.
Clear Needle Cov.d
Needle uncovered.
Hazy.
Therm.r with Needle.
Cumulus.
Sep.t 8.
N.o 10.
Cloudy.